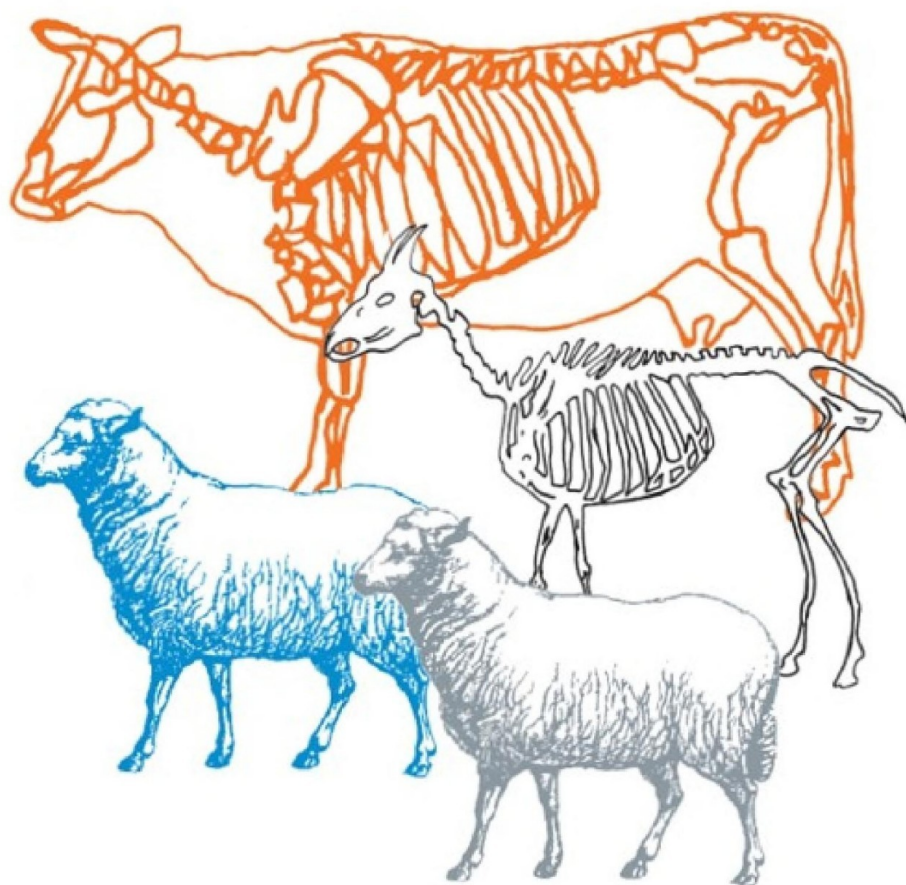


APPROACHES TO ANTHROPOLOGICAL ARCHAEOLOGY

Animal Husbandry in Ancient Israel

A Zooarchaeological Perspective on Livestock Exploitation, Herd Management and Economic Strategies



Aharon Sasson

ROUTLEDGE

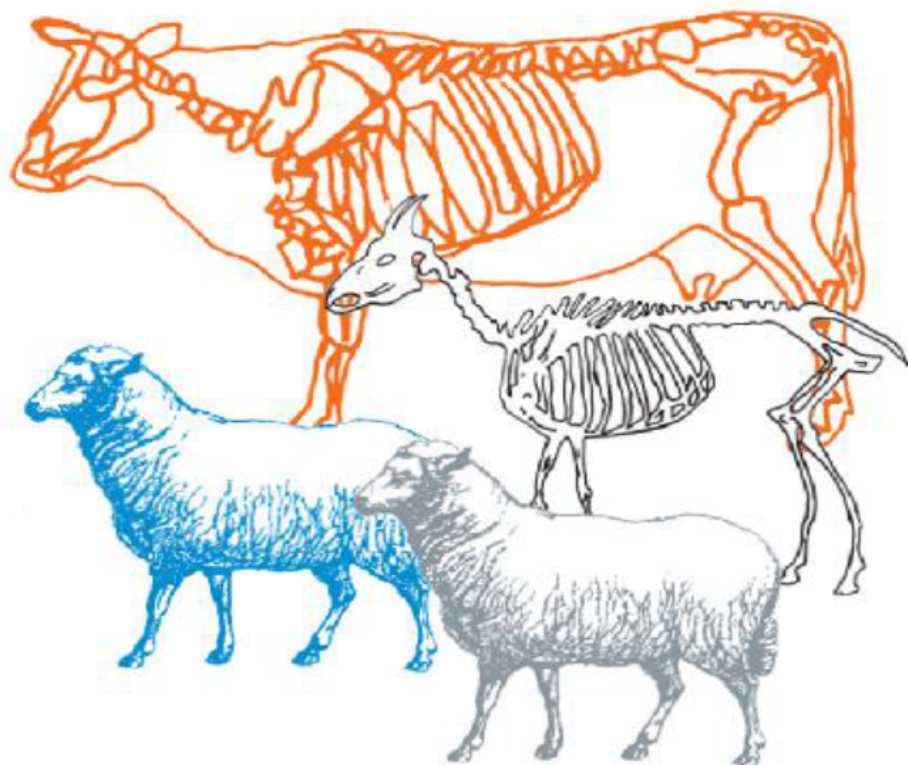

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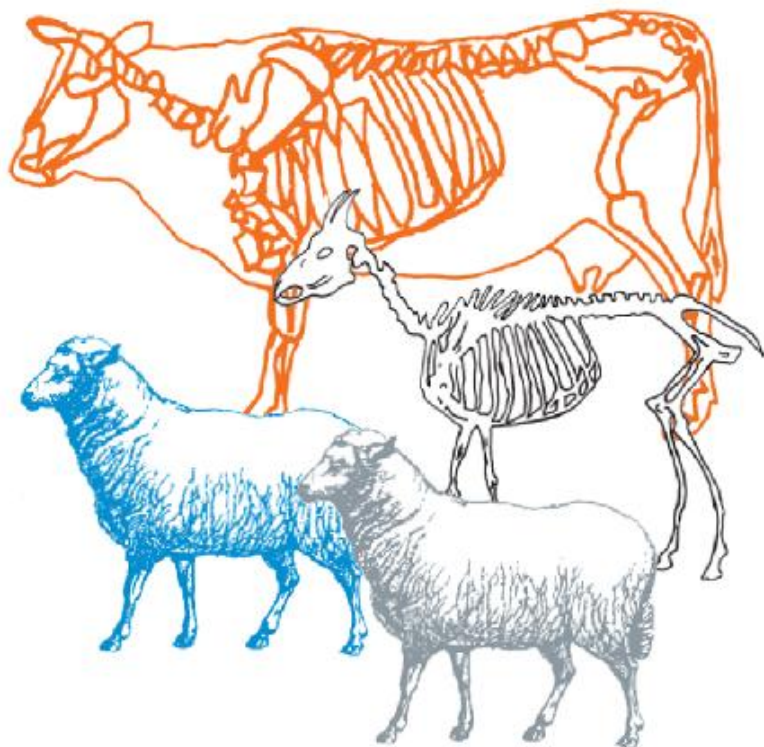
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Animal Husbandry in Ancient Israel

Approaches to Anthropological Archaeology

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A Zooarchaeological Perspective on Livestock
Exploitation, Herd Management and Economic Strategies

Aharon Sasson

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To my mother Victoria
My brother Joseph
And my daughters Shahar and Gal
For your support

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We make a living by what we get, but we make a life by what we give (Winston Churchill).

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And He said unto me: 'Son of man, can these bones live?' And I answered: 'O Lord GOD, Thou knowest' (Ezekiel 37:3).

On the Zooarchaeological Perspective

The book demonstrates various methodologies to make these bones live. It is aimed at diverse crowds. While it provides an extensive data on animal husbandry in the Southern Levant for the professional zooarchaeologist, it is also aimed at the professional archaeologists and readers that are interested in the archaeology of the Bronze and Iron Age. For this reason, the book includes introductory sections that precede the zooarchaeological discussions. These sections provide to the non-zooarchaeologist brief details on zooarchaeological and taphonomic methods, the GIS methodology, models of animal husbandry and an extensive reference source on these issues.

Faunal remains are closely tied to human presence. This is particularly accurate in referring to historical periods, the time span discussed in this book. Archaeological excavations generate a high volume of animal bones. Animal bones are the second most abundant find in most archaeological excavations subsequent to stone tools or pottery shards. The reasons for their abundance are that bones are well preserved and relatively simple to collect in an archaeological dig (compared to archaeobotanical finds for instance). Even when sieving is not practiced in archaeological sites from historical periods, copious animal bones are often collected. Consequently, a broad database is compiled and it enables us to use methodological analysis and reliable inference.

Zooarchaeology, the analysis of faunal remains from archaeological sites, may be divided into two major branches, one that focuses on prehistoric periods and the other that focuses on historical periods. The primary distinction relates to the fauna utilized at these sites. Wild and pre-domesticated animals were the principle subsistence resource of prehistoric populations. In contrast, populations from historical periods whether pastoral nomads, rural or urban, founded their subsistence economy on domesticated animals, hence bone assemblages from these sites are dominated by livestock species.

The temporal focus of this book spans the early historical periods where some of the most important social evolutionary trajectories in the ancient Near East took place, from the emergence of the earliest cities during the Early Bronze Age, ca. 3000 BCE, to the rise of the first historic states during the Iron Age, ca. 1200–586 BCE.

The archaeology, history, and socio-economy of the Bronze and Iron Age in the Southern Levant has been discussed in numerous books (e.g. Levy 1998; Mazar 1992; Finkelstein and Silberman 2001; King and Stager 2001) showing

that these periods are characterized by a vast sedentary population, either rural or urban, who left behind plentiful evidence including faunal remains. Ever since caprines (sheep and goats) and cattle were domesticated, they predominate most of the zooarchaeological assemblages in the Levant (Buitenhuis 1990; Hesse 1995a). Naturally, the focus of this book is the three most common livestock species of the Bronze and Iron Age: sheep (*Ovis aries*), goats (*Capra hircus*) and cattle (*Bos taurus*). Sheep and goats are frequently discussed as one group and will be referred as ‘caprines’.

A relatively high proportion of pig (*Sus scrofa*) remains may also be found on some of the Bronze and Iron Age sites (e.g. Hesse 1990; Hesse and Wapnish 1997; Rabban-Gerstel *et al.* 2008). Other livestock species generally represented in zooarchaeological finds from historic periods are the camel, horse and donkey (Grigson 1995). The reason for high frequency of caprines, cattle and occasionally pig bones in contrast to low frequency of beasts of burden bones (camel, donkey and horse) is related to the way these species were utilized. The first group comprises of animals consumed for food (O’Connor 2003:78) while the latter is a group of animals used as beasts of burden. As will be demonstrated below, numerous zooarchaeological reports show that animals consumed for food are found in proximity to their consumption area, namely within the inhabited site. Draught animals, on the other hand, were not consumed and were most likely dumped or buried outside the inhabited site. For this reason, the dearth of their remains should not be interpreted as reflecting their rarity. Consequently, animals consumed for food such as caprines and cattle will be discovered in high frequencies, while beasts of burden such as donkey or camel will be represented in low frequencies in the zooarchaeological assemblages. Apparently, studies of faunal remains are not always incorporated with the archaeological investigation of a site (Albarella 2001). Grigson has expressed that bluntly stating:

It is surprising that archaeologists have been so incurious about the ways in which people actually obtained their daily bread. Politics, social systems, statehood, the beginnings of urbanism, warfare, architecture and the manufacture of pottery and flint tools are all legitimate subjects for study, but none would have been possible without the provision of plant and animal food (Grigson 1995:245; see also Perry 2007).

Among zooarchaeologists, however, there is no doubt of the necessity of the zooarchaeological outlook. We may summarize the central attributes of the zooarchaeological perspective, particularly in sites from historical periods, as follows:

1. Populated sites in antiquity will normally provide us with zooarchaeological finds. The zooarchaeological evidence, as other archaeological finds, must be addressed.
2. The zooarchaeological evidence is normally rich and generates an adequate and reliable database for analysis.
3. As will be demonstrated in this book, animal bones as food waste are a

substantial means for assessing human diet, social complexity and economic dynamics.

The Zooarchaeological Research of the Bronze and Iron Age in Israel: A Brief Overview

As will be discussed below, the mass of the zooarchaeological record is only one factor in the evolution of zooarchaeology into an influential research field. One would mark the 1980s as a breakthrough in the zooarchaeological research. Four significant textbooks on the study of animal bones were published in the years 1984–1987 (Grayson 1984; Klein and Cruz-Uribe 1984; Hesse and Wapnish 1985; Davis 1987a). Furthermore, four volumes of the proceedings of the International Council for Archaeozoology (ICAZ), ‘Animals and Archaeology’ were published in 1983 and 1984 (Clutton-Brock and Grigson 1983a, 1983b, 1984a, 1984b). It is worth noting that five of the authors mentioned above carried out studies of faunal remains from sites in Israel (Clutton-Brock 1979; Wapnish 1984; Hesse 1986; Grigson 1987; Davis 1988). The large number of prominent studies published in these years indicate a shift from a secondary scholarly field into an independent discipline. A second wave in the development of zooarchaeology as an influential discipline may be observed in the subsequent decade, the 1990s and early 2000s (Lyman 1994b; Reitz and Wing 1999; O’Connor 2000). In addition, in 1993 the first conference on the zooarchaeology of the ancient Near East took place (Buitenhuis and Clason 1993). The year 1995 may be considered as a benchmark in the zooarchaeological research of the Southern Levant. A group of scholars led by Øystein LaBianca published an entire volume dedicated to faunal remains as part of the archaeological investigation of Tel Hesban in Jordan (LaBianca and Driesch 1995). This was the first and only instance to date where a publication of an archaeological site included an entire volume dedicated solely to the analysis of animal bones.

The 1980s and 90s were also rich with studies establishing models of animal husbandry in historical periods. These models discuss the relative frequency of sheep, goat, swine, camel and cattle, marketing strategies of these species and exploitation strategies of their products (e.g. Davis 1980; Sherratt 1981; Wapnish 1984; Kohler 1984; Hesse 1990). Sherratt (1983) discussed the origin of secondary products (milk, wool, transportation) production. Cribb (1984) conducted a computer simulation in order to examine various kill-off (i.e. culling) strategies in caprine herds. Redding (1984) studied the sheep/goat ratio and suggested possible goals reflected by this ratio: maximizing energy (calories) and protein intake (through their products; i.e. meat and milk) or herd security. Wapnish and Hesse (1988) proposed three strategies of animal exploitation and consumption ranging between a self-sufficient economy to a producing economy. Tchernov and Horwitz (1990) examined the caprine/cattle

ratio in relation to climatic regions in Israel. Zeder (1991) suggested a model of direct and indirect consumption of livestock in urban sites. Grigson (1995) studied the relative frequency of caprines and cattle and their relative contribution to meat production. One of the first models was in fact published in 1973, a decade before the major breakthrough. Payne (1973), in his pioneering work, proposed three mortality profiles of caprines; each reflects utilization of caprines for either meat, milk, or wool. [Chapter 2](#) of this book revisits many of these models and theories.

One of the earliest zooarchaeological reports discussing sites from historical periods in Israel was published by Pier Ducos in 1968. Ducos (1968:111–21) studied three Bronze Age sites; Tel Erani (Early Bronze), Tel Nagila (Middle Bronze) and Naharia (Late Bronze). A number of zooarchaeologists followed Ducos and left their mark on the zooarchaeological study of Bronze and Iron Age sites in Israel. Simon Davis has studied the fauna from sites such as Tel Arad, Tel Qasile, Tel Qiri and Tel Yarmouth (Davis 1976, 1985, 1987b, 1988). Shlomo (Salo) Hellwing studied various sites including Tel Beer-Sheba, Izbet Sartah, Tel Kinrot, Tel Michal, Tel Dalit, Tel Aphek and Tel Shiloh (Hellwing 1984; Hellwing and Gophna 1984; Hellwing 1986, 1988–89; Hellwing and Feig 1989; Hellwing *et al.* 1993). Paula Wapnish and Brian Hesse who worked mainly in Israel in the 1980s and 1990s made a profound contribution to the zooarchaeological research of ancient Israel. Their work went beyond faunal remains analysis and included theories and models, which contributed to a broader understanding of animal husbandry (Wapnish and Hesse 1988; Hesse 1995b; Hesse and Wapnish 2002). Wapnish and Hesse have been involved in long-term archaeological projects such as those of Tel Miqne, Tel Dan and Tel Megiddo (Hesse 1986; Wapnish and Hesse 1991, 2000). Liora Kolska-Horwitz is probably the most prolific zooarchaeologist with numerous papers contributing to the zooarchaeological research of the Southern Levant. Horwitz has covered in her research a wide spectrum from prehistoric periods (e.g. Horwitz 2004) up to the late Islamic periods (e.g. Horwitz 1999a). She has conducted various studies of recent faunal assemblages that provide us with a better knowledge of the zooarchaeological evidence (e.g. Horwitz 1990; Horwitz and Smith 1990) as well as broad studies of animal exploitation in ancient Israel (e.g. Horwitz and Tchernov 1989; Horwitz and Milevski 2001). While seven faunal assemblages studied by Horwitz are referred in this book ([Chapter 2](#)), the list of all sites studied by her is too long to mention.

The above scholars and many others have generated a large zooarchaeological database of sites from the Bronze and Iron Age and later periods. A major portion of this database, joined with models of caprines and cattle exploitation, will be analyzed below.

What Is This Book About?

‘You are what you eat’ goes the adage, which is applicable to the interpretation

of the archaeological record too. Animal bones found in archaeological sites are normally food refuse discarded by its inhabitants.

What is to be learned from food waste, particularly when it originated with three primary species: sheep, goats and cattle? This book offers four views on animal husbandry: comparative, spatial, sagittal and an ethnographic perspective. Three of these outlooks are founded on zooarchaeological evidence.

The Comparative Perspective

[Chapter 2](#) comprises comprehensive theoretical discussion of economic strategies—a market economy and the survival subsistence strategy, pastoral-nomadism and sedentism. The comparative perspective is applied here by studying vast anthropological data from pastoral-nomads in various regions of the world as well as comparative analysis of zooarchaeological data from numerous archaeological sites in the Southern Levant. In this chapter, I show that the survival subsistence strategy rather than a market economy was prevalent throughout the Bronze and Iron Age among most households. Nomadism is evaluated here as the most successful survival subsistence strategy. The sedentary population of the Bronze and Iron Age provided us with wide-ranging zooarchaeological evidence to be studied. Three of the most common topics often discussed in zooarchaeological reports of Bronze and Iron Age sites are re-examined here: the sheep/goat and caprine/cattle ratio and strategies for the exploitation of caprines and their products. Data related to these three issues was compiled from 70 sites and strata. A comparative analysis of the data supports the model of the survival subsistence strategy presented in this book.

The Spatial Perspective

The spatial perspective provides us with a study of faunal remains from a solitary archaeological level of occupation—Stratum II at Tel Beer-Sheba, Israel.

Stratum II represents an ideal site for spatial analysis. Two-thirds of it was excavated, revealing defined architectural components of this town such as 75 houses, three principal streets, storehouses and a city wall. The spatial analysis was carried out using an innovative and computerized technology—the GIS (geographic information system). The GIS application enabled us to virtually ‘return’ all identified animal bones to the archaeological loci they were discovered at and generate a picture of the spatial distribution of faunal remains at the site. The computerized platform enabled us to address numerous multifaceted queries such as the spatial distribution of faunal remains indoors and outdoors, the spatial distribution of caprines versus cattle, sheep versus goats and the spatial distribution of hundreds of caprine astragali found at

Stratum II. One of the fascinating queries addressed in [Chapter 4](#) was whether social stratification in Stratum II can be identified through patterns in the spatial distribution of meat-rich and meat-poor skeletal elements.

The Sagittal Perspective

The sagittal perspective represents a taphonomic study of the faunal assemblage from Stratum II at Tel Beer-Sheba. Zooarchaeological finds from tel sites undergo four primary taphonomic phases starting with the phase the animals were utilized in antiquity, through the phase when their remains were discarded at the site, later through the phase these faunal remains were buried naturally during the site formation and ending at the phase when these animal bones are unearthed in an archaeological dig and studied at the zooarchaeological lab. In other words, faunal remains start as live animals consumed by the site inhabitants, shift downwards to the site's topsoil as food refuse and shift interiorly into archaeological relic during the formation of site. [Chapter 5](#) demonstrates a taphonomic study carried out for the first time on a faunal assemblage from a tel site, investigating the entire vertical process starting with the live animal and ending at the zooarchaeological lab. The sagittal perspective presented in [Chapter 5](#) clearly shows that the bone assemblage of Tel Beer-Sheba was altered a number of times during this process. Thus taphonomic study should precede any socio-economic study (historic as well as prehistoric) that is based on faunal remains.

The Ethnographic Perspective

The ethnographic perspective provides us with data that cannot be obtained solely from faunal remains. In order to evaluate the contribution of caprines and cattle products (meat and milk) to the human diet, I made use of data compiled from demographic and animal censuses carried out by the British government in Palestine in the 1940s (Government of Palestine 1943, 1945). The animal census provides us with valuable data on the distribution of livestock species and their sex and age in traditional, premodern villages. This data made it possible to estimate the total amount of milk, meat, fat, protein and calories produced from caprines and cattle in each village. The analysis presented in [Chapter 6](#) demonstrates quantitatively that the contribution of livestock products to the human diet was diminutive. Nonetheless, it is apparent caprines and cattle provided essential high-value proteins.

In sum, this book provides various outlooks on the Bronze and Iron Age animal husbandry in the Southern Levant. Although the book discusses for the most part data of sites in ancient Israel, I believe the conclusions presented here reflect a picture of animal husbandry of the whole region of the Southern Levant. The approaches taken here, GIS analysis, taphonomic investigation, comparative analysis and ethnographic study, are diverse and do not overlap

each other for the most part. Nonetheless, the conclusion arising from all studies is that the economy (as reflected in animal husbandry) in ancient Israel was self-sufficient and managed conservatively. The survival subsistence strategy rather than a market economy was paramount among most parts of the Southern Levantine population.

A Comparative Perspective: The Survival Subsistence Strategy—Animal Husbandry and Economic Strategies in the Bronze and Iron Age

Introduction

Lewis Binford, in one of his earliest works, advocated the anthropological approach in archaeology. He proposed that ‘change in the total cultural system must be viewed in an adaptive context both social and environmental’ (Binford 1962:217). This chapter will discuss humans and animals in their socio-economic and environmental context. The theme of the chapter is a reassessment of economic strategies practiced in the Bronze and Iron Age period as reflected by the zooarchaeological record from numerous sites in the Southern Levant.

The prevailing idea of the economic system in the Bronze and Iron Age, advocated by many scholars, historians, archaeologists and zooarchaeologists, is that all populations—pastoral nomads, rural and urban, specialized in various branches of agricultural production. Animal products such as meat, milk and wool or plant crops such as grain and oil served as merchandise in ancient market economies. Woolley, a pioneer archaeologist of the Southern Levant, asserted long ago that barley harvested in the Beer-Sheba valley was traded with Phoenicia (Woolley 1946:180). Greenberg (2002:13) studied Early Bronze sites in the Hula Valley in northern Israel. He writes ‘the village system of the Levant lost its autarkic innocence—so to speak—at the beginning of EB II, and it never returned to the status of a nearly self-enclosed system which it enjoyed in EB I and earlier periods’. Mazar (1992:118), who discussed the agricultural system in the Early Bronze Age II-III, proposes that agricultural specialization was an essential economic factor at that period. According to Mazar, the hill country settlements in Israel traded oil and wine with the cities of the plains and with semi-nomadic pastoralists who supplied meat and hides. Fall *et al.* interpret the abundance of sheep bones compared to goats in the Early Bronze Tell el-Hayyat, located in the Jordan valley, noting that: ‘This trend implies increasingly market-oriented animal husbandry’ (Fall *et al.* 1998:117; see also Fall *et al.* 2002). Levy, in his discussion of the diachronic changes in pastoralism in the Northern Negev, argues that:

Unlike the mixed farming/transhumance system which characterized the Chalcolithic period, EB specialized herdsman husbandry seems to have developed to provide secondary products for the growing population in the Early Bronze urban centers and as a response to the new political landscape (Levy 1992:75).

Finkelstein and Silberman (2001:117) state that in the Middle Eastern society, pastoral nomads traded their products (dairy products, meat and hides) with settled villages that provided agricultural products in return. According to Grigson (1995:245–48), by the third millennium, a market economy was operating and animals were used as segments of exchange, particularly with urban communities. Rosen (1995:40–41), who discussed economic strategies in the Early Bronze Age, affirms that specialization in agricultural production and a market economy were prevalent in this period (Rosen 1995:40–41). In review of the animal husbandry in the ancient Near East, Hesse (1995a:205 and see also Hesse 1999; Hesse and Wapnish 2001; Wapnish and Hesse 2003) says that,

During the Neolithic, households and communities had concerned themselves with products for their own direct needs, a pattern often referred as ‘the domestic mode of production’. In the late prehistoric and early historic periods, however, encouraged by developments of opportunities in regional systems of exchange or perhaps forced by the demands of powerful elites, people began to make new choices about what to herd and how to manage their flocks. This new basic husbandry was designed so that products with the best ‘market’ value could be generated. The basic pastoralist interest in food and family became refocused on commodities and customers as political economies emerged in the new stratified social order.

Whitelam (1986:170) states that urban centers in the Iron Age period provided a regional market for local agricultural and pastoral produce. According to Holladay (1995:386) who studied the economy of the kingdoms of Israel and Judah, domestic flocks were kept in agricultural communities as means of turning crop surplus into easily sold resources. Hopkins (1996:124–5) distinguishes between two economic zones in ancient Israel of the Iron Age II –the rural zone that produced exclusively for self consumption while the urban zone maintained a market-oriented production.

To summarize the above, many scholars conclude that a market economy was prevalent in the Bronze and Iron Age, surplus was produced for export, urban centers functioned as marketplaces, and animal products among other agricultural crops were used as segments of trade.

Before laying out my ideas on the prevailing economic strategy in the ancient Near East, two terms ought to be clarified: market economy and surplus. How can we tell that a market economy system was operating? Can we deduce from an assemblage of Mycenaean vessels or a few dozen Egyptian ceramic sherds uncovered in sites in Israel or Jordan that a market economy system was effective? Did ancient Egyptians or Mycenaeans actually trade on a regular basis with ancient Levantine sites? In societies lacking a monetary economy, social relations were most likely bound by a series of gift exchanges (Mauss 1954; Dyson-Hudson and Dyson-Hudson 1969; Keswani 1994). Ingold proposes to distinguish between gifts which represent social relations and commodities that represent economic relations,

The commodity is a thing that ‘changes hands’ by becoming wholly detached from one person and subsequently attached to another, quite unrelated person. The exchange of commodities creates a quantitative relation between objects, expressible as a ‘price’ of one in terms of the other. No such relation is established by the exchange of gifts, rather what is set up is a qualitative relation between

We may therefore presume that imported pottery or other artifacts do not necessarily imply an organized trade. They might have been served as a gift or as a temporal exchange of goods. In other words, not all exchanged goods were produced intentionally for 'export' or trade and not all transaction of goods meant a market economy. This mode of exchange is described by economic anthropologists as reciprocity, risk-free trading, non-market or marketless economy (Polanyi 1957a:250–5, 1957b; Dalton 1971a:131–4; Sahlins 1972:191–6; Renfrew and Bahn 1991:310). It is reasonable to assume that exchange of goods in the Bronze Age was meant to build and strengthen social relations rather than establish markets and gain wealth. Firth (1951:136), who studied this topic, suggested that, 'The ties between producers tend to reach out beyond this common interest in the act of production and its rewards alone. A production relationship is only one facet of a social relationship'.

It appears that there is confusion in defining a market economy in antiquity. Perhaps the reason for that is related to the 'smallness of scale' as Wilson (Wilson 1941:10) states: 'It is the smallness of scale, so hard for modern European to grasp imaginatively, which is the fundamental characteristic of primitive life'. Dalton provides us with additional clarification of this confusion. According to Dalton (1969:67), anthropologists (and in our case I would add archaeologists and zooarchaeologists) assume that 'what is true for peasant economies is also true for primitive economies'. However, in 'peasant economies', production for market sale, the use of Western money, and other features of market economies are present, while in 'primitive economy', 'crucial features of markets organization, which allow analysis in market concepts and measurement in money terms, are absent'. Polanyi (1944:45; see also Polanyi 1957a, 1957b) has stated over half a decade ago that a market economy can only exist in a market society and must encompass all elements of industry, labor, land and money. Dalton (1971a:63) referred to the mix-up in terms in other studies and said: 'The attempt to translate primitive economic processes into functional equivalents of our own inevitably obscures just those features of primitive economy which distinguish it from our own'. Moreover, Dalton advised us to refrain from using the term 'economy' in the context of traditional societies:

It would be better to say that there is no awareness of the 'economy' as a distinct set of practices apart from social institutions. Transactions of material goods in marketless economies are expressions of social obligation, which have neither mechanism, nor meaning of their own apart from the social ties, social obligations, and social situations they express. *In the Western meaning of the word, there is no 'economy' in traditional society; only socio-economic institutions, processes, and transactions* (Dalton 1971a:64. My emphasis in italic letters).

Sahlins (1971b: 51; 1971a:30) who studied the exchange mechanism among primitive households concluded that exchange should be associated with 'noneconomic' relations and that 'exchange and the production for it, are

geared to livelihood not profit’.

In summary, exchange of goods and agricultural products most likely occurred in the Southern Levant. However, it does not necessarily reflect a market economy system. Furthermore, an exchange of agricultural products does not imply specialized production in a market economy. The zooarchaeological record, as portrayed in [Chapter 3](#), points to a non-specialized production.

Surplus in ancient economies should be characterized and elucidated as well. Is surplus in traditional societies necessarily related to wealth, a market economy or even an exchange economy? Hesse (1999:107), in his discussion of the faunal remains of Khirbet Raddana, states: ‘Thus some part of the cull from a flock is aimed at a pastoralist’s own household food needs while the rest is marketed for its exchange value’. According to Hesse, surplus was designated for ‘export’ and marketing (see also MacDonald 2008:48). Fall *et al.* (1998:110), in their discussion of the Bronze Age economy in the Southern Levant, conclude that agricultural surplus was marketed to the cities: ‘The earliest Near Eastern cities depended, to varying extent, on agricultural surpluses provided by farmers and herders in the countryside’. Herzog (1997:9; see also Herzog and Singer-Avitz 2004:231), in his discussion of the emergence of social complexity, suggests that surplus was aimed at improving standards of living: ‘It would be more realistic to assume that such farmers, when blessed with plentiful harvests, would like to improve their own standard of living and therefore invest in more comfortable housing, better working tools, new clothing, rare prestige items or simply consume more food’. Conversely, I argue that surplus should not be necessarily associated with a market economy, trade or wealth, especially if we acknowledge the idea that a market economy system in the Ancient Near East was not prevalent. It is most likely that the common household in the Bronze and Iron Age strived for economic security and survival rather than accumulating wealth. Creating surplus, as described by Jochim was one of the ‘maintenance strategies’ for survival: ‘in long-term decision making, the planning of surplus becomes a likely response to uncertainty’ (Jochim 1981:210, see also Widstrand 1975:150). Johnson studied methods of coping with economic insecurity among peasants in Brazil. He states:

The way to reduce the risk would be, of course to have a bank account to fall back upon in case of bad decision or bad luck. But the risk alternative is not viable alternative for the peasant because no banks exist for him. His solution is to try to store enough crops to feed himself for a year (Johnson 1971:145).

According to Johnson (1971:143), this mechanism refers to all peasants who live at a low subsistence level. Sahlins (1971b:46), in his discussion of ‘the familial mode of production’ determines that domestic production was allocated to provisioning the family with its customary needs and has no inherent propensity to surpass wealth. In another paper Sahlins states that if

the household produces surplus for exchange ‘the exchange and the production for it, are geared to livelihood not profit’ (Sahlins 1971a:30). Allan (1971:97), in his study of farmers in Northern Rhodesia, concludes that, ‘The surplus was an essential safeguard and an important element in the economic and social structure of tribal societies’. Accumulating stock could therefore have been a means to ensure security and for coping with environmental fluctuations or any other unexpected hazards. In other words, surplus of livestock and animal products were produced—yet, not as a commodity designated either for ‘export’ or for gaining wealth. Surplus when created was banked to cope with downfall periods or was exchanged to maintain the limited demands of the domestic group (Widstrand 1975:149; Ingold 1980:134–40; Jochim 1981:176; Rowley-Conwy and Zvelebil 1989; Halstead 1993).

It appears that the meaning of surplus was projected falsely by archaeologists and zooarchaeologists from complex economies to primitive ones. Dalton (1971a:202) referred to this confusion in terms as well, saying ‘as it is used in a market-organized economy, the term surplus has special meaning wholly unlike its meaning in non-market economies’.

The debate on self-sufficient versus market economy in the Southern Levant continues into the later periods. Safrai (1994:415), in his manuscript on the economy of the Land of Israel in the Roman period, states that a ‘key question’ is whether the economic system of Judea was ‘open’ or ‘closed’. Safrai uses the term ‘open economy’ to describe a system in which the farmer was extremely dependent on trade and commerce. The farmer in this system used some of the crops he produced but the larger portion of production was sold to the markets and with the income, the farmer bought all other goods that he needed. In contrast ‘closed economy’ is where farmers produced more or less their own food needs.

My idea of an ancient economy and its distinction from a market economy might as well be illustrated through paradigm proposed by Karl Marx. Marx identifies two economic modes:

The simplest form of the circulation of commodities is C–M–C, the transformation of commodities (C) into money (M), and the change of the money back again into commodities; or selling in order to buy. But alongside of this form we find another specifically different form: M–C–M, the transformation of money into commodities, and the change of commodities back again into money; or buying in order to sell. Money that circulates in the latter manner is thereby transformed into, becomes capital, and is already potentially capital (Marx 1889:146).

These forms might be applicable to primitive economy if we take money out of the equation. Marx’s ‘simple circulation of commodities’ represents my idea of ancient economy, exchange of commodities for their value with no aspiration for profit or wealth. In contrast, Marx’s ‘general formula of capital’ may represent the concept of market economy. Surplus is created and traded in order to gain wealth and expand the value of commodities. Marx described the capitalist in these words:

The expansion of value, which is the objective basis or main-spring of the circulation M—C—M, becomes his subjective aim, and it is only in so far as the appropriation of ever more and more wealth is the abstract becomes the sole motive of his operations, that he functions as a capitalist, that is, as capital personified and endowed with consciousness and a will (Marx 1889:151).

I argue therefore that the use of terms such as ‘specialized economy’, ‘market economy’, and ‘surplus’ in describing the household economy in the Southern Levantine Bronze and Iron Age were falsely adopted from a modern capitalistic concept. Limited exchange of commodities most likely occurred among households yet not systematically, and certainly not as an element of a market economy. Surplus most likely was produced on occasions, yet not systematically, certainly not as means for building wealth.

The Survival Subsistence Strategy

The goal of humans in herding animals is not capitalistic undertaking aimed at production of a marketable surplus. Its aims are rather regular provision of good supply to enable the herding group to survive physically and socially, and the maximization of the probability that the group would survive (Widstrand 1975:149).

In this section, I shall propose an alternative interpretation of the principal economic strategy in the Bronze and Iron Age. It is founded on quantitative analysis of the zooarchaeological record from 70 sites and strata in the Southern Levant and extensive study of anthropological literature on pastoral-nomadism. I term this economic strategy ‘survival subsistence strategy’. Wharton (1963:50) has suggested that we distinguish between ‘subsistence’ as a term describing a minimal degree of commercialization and ‘subsistence’ to describe a minimal level of living. According to Wharton, in most cases a condition of subsistence production (i.e. commercialization) is accompanied by very low levels of living. As described in the previous section and elaborated in this section, the term ‘subsistence’ may be used here in both meanings. I adjoin the prefix ‘survival’ to emphasize that this strategy was not aimed at merely daily subsistence but at a long-term physical existence of the individual, household or clan. It is a ‘survival strategy’ rather than simply a subsistence strategy because failure in the maintenance of this strategy might bear fatal consequences. It is a strategy because it has involved long-term, premeditated institutions and decisions that affected all aspects of livelihood. The survival subsistence strategy was probably the strongest, most pervasive active force inherent in people (Hayden 1975:17) and aimed at maintaining a long-standing continued existence over many generations. Allan, who studied farmers in Northern Rhodesia, provides us with a vivid illustration of how feeble are the lives of these households:

In most years there was food to spare and in poor years a sufficiency that ensured survival, but, unless it had been preceded by an exceptionally good season, a year of catastrophe—by drought, flood, locusts or other pests—meant famine, and, if not the destruction of the community, at least temporary dispersal and reduction of its members (Allan 1971:97).

Maintaining this strategy was fundamental to the household livelihood that it overcame and probably dictated social forces and dynamics. Johnson exemplifies how essential was this strategy:

Peasants at the margin of subsistence can never forget that they have no possessions or wealth to cushion them from a stroke of bad luck. Even without some calamity such as bad weather or disease, they watch helplessly as they and their children lose weight each year before the new harvest begins. The uncertainty of the weather, the chronic shortages of cash and food, and an insecure relation to the land are matters over which the poor peasant has no direct control. He has no reasonable alternative to respond by emphasizing his own security, even when he must sacrifice pride and profit to do so (Johnson 1971:149).

The reason the survival subsistence strategy has been maintained for numerous generations is prosaic; it has historically been proven successful. Outstanding evidence for this success is the fact that households who have maintained this strategy obviously survived (Wharton 1971:151). Lipton (1982:261) provides us with additional reasoning why this strategy would be fundamental to most households in antiquity, which he coins as the 'vicious circle of poverty'. According to Lipton, 'poor farmers lack personal assets and social security, so they are reluctant to make risky investments which would raise their output'. Thus, subsistence insecurity forced ancient societies to practice a conservative economic behavior.

The survival subsistence strategy stands in contrast to market-oriented strategy, which was a specialized economy aiming at surplus production (of livestock in our case) in order to attain wealth or political power (Neale 1971:25). Marshall Sahlins defines the disparity between the two strategies somewhat poetically: 'There are after all two roads to satisfaction, to reducing the gap between means and ends: producing much or desiring little' (Sahlins 1971b:49). I shall make use of this phrase to demonstrate the two contrasting strategies. While households that were engaged in a market economy aimed at expansion of value (Marx 1889:151) or in Sahlin's words, producing much, households that practiced the survival subsistence strategy strived to secure their livelihood by desiring little.

How was the survival subsistence strategy maintained? The underlining principle would have been to preserve subsistence resources (e.g. livestock, water, agricultural and pasture lands) at an optimal level (rather than maximal) in order to sustain the household needs but not beyond that point (Ingold 1980:134; Jochim 1981:174-5; Widstrand 1975:149). The reason was that scarcity rather than abundance played a critical role in the lives of ancient populations in the Southern Levant (Halstead and O'Shea 1989:6; Dalton 1971b:9). By preserving those resources and minimizing risks, stability and long-term survival is accomplished. Hayden (2000:111) describes this strategy as: 'a relative dynamic equilibrium that minimized episodes of resource stress' (see also Rosenberg 1998; Spooner 1971:206). Redding (1993:80; see also Redding 1988:90) discussed the struggle for subsistence security in several papers. He portrays the mechanism for coping with scarcity saying 'one of the

strongest selective pressures operating on human behavior is, and has been, for minimizing fluctuations in the resource base, or maximizing subsistence security’.

Jared Diamond, author of ‘Collapse’, reviews the causes for some of the great civilizations of the past collapsing into ruin, and what is to be learned from their fate. Diamond illustrates the process that might lead to collapse:

A series of good years, with adequate rainfall or with sufficiently shallow groundwater tables, may result in population growth, resulting in turn in society becoming increasingly complex and interdependent and no longer locally self-sufficient. Such a society then cannot cope with, and rebuild itself after, a series of bad years that a less populous, less interdependent, more self-sufficient society had previously been able to cope with (Diamond 2005:143).

The lesson from Diamond’s examples is clear: imperiling subsistence resources might end with calamity while preserving these resources most likely will ensure survival.

How fundamental was the endeavor for minimizing risks? Jongman and Dekker (1989:116–17; see also Lipton 1982:264; Mace 1993) demonstrate the advantages of minimizing risks over striving for accumulation of wealth in the pre-industrial world. They reason that stable income was preferable to an income that was highly variable but with identical mean. The logic in risk avoidance is that the distress of losing £100 spent on luxury is far less than the distress of losing the last £100 necessary for physical survival. Therefore, the pain of losing £100 (or caprine heads in our case) is larger than the satisfaction of gaining them. According to Jongman and Dekker, the majority of the population in the pre-industrial world lived very near subsistence level. According to Jochim (1976:5–10), decision-making under uncertainty has been approached by the technique of game theory, as a one-person game against nature. In a model for decision-making, he proposes that economic behavior is the result of conscious, deliberate and rational choices and that the choices seek to satisfy predetermined aspiration levels, not to maximize any specific measures. Wharton (1971:170) who discussed models of coping with risk and uncertainty has reached the same conclusion: ‘Profit maximization may not be as important in a subsistence or barter economy as the maximization of security and survival’. Wade (1974:1191) discussed the attempt to export Western agricultural techniques to the Third World. He underlines that: ‘The peasant farmer’s first goal is not to maximize his profits; it is to minimize his risks’. Binford (2001:193), in his inspiring synthesis of cultural and environmental information, provides us with his outlook on minimizing risks and human behavior: ‘Humans tend to organize their labor and their activities in a way that reduces the risk associated with accessing critical resources, and they tend to organize into cooperative social units in order to minimize any uncertainty associated with the dynamics of their social and ecological environments’.

Population Size and the Survival Subsistence Strategy

It is an obvious truth, which has been taken notice of by many writers, that population must always be kept down to the level of the means of subsistence (Malthus 1798:2).

Thomas Malthus in 'An Essay on the Principle of Population' defined the relationship between population size and subsistence resources (Malthus 1798). This notion is important, bearing in mind an opposite force; a social group, whether a household, tribe or larger ethnic group, would naturally strive to increase its population size. The rationale for increasing population size is evolutionary and socio-political. The evolutionary principle, as discussed below, states that a larger number of individuals per group would secure its gene propagation. The socio-political principal is that a larger household, for instance, would be considered dominant compared to a smaller household. Socio-political power normally enables the household, tribe or other ethnic group to have control over lands, natural resources (e.g. water, pasture) and other means that secure its existence and welfare. The two opposing forces will be discussed here in light of the survival subsistence strategy.

Justus von Liebig (1842), a biological chemist who studied the effect of individual nutrients on crops, propounded the 'Law of the Minimum'. Liebig's formula determines that if a plant is lacking a substantial nutritive element, its growth will be poor even when all other nutritive elements are abundant. This law can be extended to other biological populations, such as people or livestock herded by people: the size of a biological population may be limited by the minimum amount of resources available to that population (carrying capacity) rather than the total or average amount of resources available throughout a given timespan. For instance, Binford (2001:175) affirms that: 'the amount of food that is available during the least productive period of the year will limit the level of sustainable population within an area'. How does a biological population determine what is the period with the minimum natural resources available and according to that regulate its size? Is it a seasonal shortage (i.e. the season with shortest resources available), or a yearly shortage (i.e. the scarcest year in a time span of five, 10 or 50 years)? This issue is intriguing and has been discussed by anthropologists and evolutionary ecologists (Barth 1959–60; Moore 1983 and see more references there). In order to underline additional aspects of the survival subsistence strategy, I shall focus for the most part on the relationship between population size and carrying capacity. Darwin in *The Descent of Man* has stressed that human populations cannot steadily and regularly increase as one would expect: 'As famines are periodical, depending chiefly on extreme seasons, all tribes must fluctuate in number. They cannot steadily and regularly increase, as there is no artificial increase in the supply of food' (Darwin 1871:51, see also Diamond 2005:143). The notion of regulation of population size is frequently invoked in the anthropological literature. Cavalli-Sforza (1996:56) states that 'Because pastoral-nomads are adapted to marginal desert environments and their way

of life is based mainly on a small range of domestic animals, they cannot reach high population densities' (see also Meir 1986:202–3). Barth (1959–60, 1962, 1964), who studied pastoral-nomads in South West Asia, has noted that these populations maintain a balance between availability of natural resources (fodder and water), number of livestock and population size. Jochim (1981:164–84), in his discussion of maintenance activities for coping with stress, affirms that 'When confronted with the probability of imbalances between population and resources, groups or individuals may focus on the population side of the equation rather than on the resource side' (Jochim 1981:181, see also Redding 1988:63). I wish to highlight a chief axis in Jochim's formula—regulation of population size occurs in conditions of stress and imbalance. In stable environmental conditions, where the resource base does not fluctuate considerably, we ought not to anticipate this *modus operandi*. Regulation of population size is well known among various societies. Fortier (2000:116) and Marlowe (2005:58) portray this phenomenon among hunter-gatherers. Brawer (1990), who studied the transformation in the rural Arab settlement in Israel, provides us with an excellent illustration for this phenomenon among a sedentary population. According to Brawer, the 1870s was the beginning of a new era for rural Palestine with the introduction of modern agriculture. In the preceding periods, the Arab village remained in a state of almost complete stagnation for over three centuries. According to Khazanov (1984:71): 'Pastoral nomadism is doomed to stagnation because its economy is extensive and allows no permanent solution to the problem of balance at the expense of intensification of production'. In other words, a continuous imbalance with no permanent solution will result in stagnation in population growth. In the case of the Arab village, the introduction of modern agriculture provided a permanent solution, which allowed them to extend carrying capacity, and allowed increase in population size. Khazanov (1984:71) provides us with an additional example of regulation of population size among pastoral-nomads. He notes that the numbers of livestock per capita among ancient tribes in Mongolia and among the Mongols in 1918 correspond almost exactly. In other words, the number of livestock limited the number of humans and the population size remained stable for many generations. Spooner has referred to this formula saying that efficiency of herding within nomadic groups 'requires maintaining a herd of optimum size and structure, which in turn requires that the local subsistence groupings or camps of the nomads must also be maintained with an optimum range of size and structure' (Spooner 1973:40–1; see also Spooner 1971:202–203; Dyson-Hudson and Dyson-Hudson 1980:32; Kressel and Ben David 1995:121; Ochsenschlager 1993:35).

If we acknowledge the idea that Southern Levantine populations in the Bronze and Iron Age suffered from unstable environmental conditions, we ought to deduce that they were doomed to stagnation for many generations. Before elaborating on this concept, two issues are noteworthy. According to Rappaport (1984:88–95) horticulturalists tend to keep the population levels

much lower than the environment and economy would seem capable of supporting. Rappaport's remark underlines two essential points: a) regulation of population size could have been prevalent amongst sedentary populations as well, b) population size would have been maintained *below* carrying capacity. The idea of regulating population levels below carrying capacity has been pointed out by Hayden (1972:206–7, 1975:12) and by Gaulin and Konner (1977:56) who asserted that 'non-industrial economies are underproducing, maintaining lower than necessary levels of population density, and producing adequate calories and a surplus of protein and leisure most of the time. This is because of the periodically occurring shortages to which they are adapted.' Rappaport's view on the horticulturalists in New Guinea ought to be projected onto other sedentary populations, including those of the Southern Levantine in the Bronze and Iron Age. Hence, it would be reasonable to assume that as pastoral-nomadic populations, sedentary populations in the Southern Levant could not increase dramatically the carrying capacity of their surroundings and had to constantly regulate their population size. Maintaining lower than necessary levels of population density is paramount for comprehending the survival subsistence strategy. As discussed above, the survival subsistence strategy prevailed in the Bronze and Iron Age. It aimed to secure the existence of Southern Levantine household and minimize fluctuations in the resource base. Utilizing natural resources to produce adequate subsistence, but not beyond that point, guaranteed long-term survival for the population even if carrying capacity dropped down below the yearly average as a result of famine or other hazards. Whether populations regulated their size based on the scarcest season or scarcest year (in a cycle of five, 10 years, or even a generation), it is apparent that maintaining population levels required a learning process and most likely trials and errors, before reaching equilibrium with the carrying capacity.

In sum, the natural resources (e.g. rainfall, water and pasture resources) available for the Southern Levantine population (nomadic and sedentary) in the Bronze and Iron Age was limited and unstable. Regulation of population size was one of the pillars of the survival subsistence strategy and was aimed at preserving the natural resources even with the price of maintaining population levels below carrying capacity.

We may conclude that the survival subsistence strategy led a conservative management of subsistence resources that favored minimizing risk and uncertainty over gaining profit. How was this strategy reflected in archaeological and anthropological evidence? As has been already discussed here, livestock was a principal component in the diet and subsistence economy of all pre-industrial traditional societies (Sasson 1998). The survival subsistence strategy was examined therefore in light of the human-animal relationship among two principal groups practicing it, pastoral-nomads and sedentary people.

Subsistence Strategies of Pastoral-Nomads

Since the agricultural revolution in the Neolithic period, the two primary groups existing in the ancient Near East were pastoral-nomads and sedentary populations (Simmons 1997:313). In this section, I shall discuss the notion of pastoral-nomadism in light of the survival subsistence strategy.

Sadly, we are not able to study pastoral-nomadism using zooarchaeological data and methods. Whether pastoral-nomads left their traces in archaeology (Rosen 1992) or not (Finkelstein and Perevolotsky 1990; Hesse 1995a:211) is still a subject of debate; it is apparent that zooarchaeological finds from pastoral-nomadic sites are negligible if available at all (Schwartz 1995:251; Zarins 1989:141). For this reason, the discussion of pastoral-nomads and the reassessment of their strategic selections is limited here to extensive ethnographic studies.

On the Nature of Relationship between Pastoral-Nomads and Sedentists

In [Chapter 6](#), I show that the rural settlement in the Central Hill in Israel practiced cereal agriculture and horticulture as well as animal husbandry (see also Sasson 1998; King and Stager 2001:112; Hesse 1995a:211). The practice of animal husbandry in sedentary settlements is widespread and most likely took place in most rural as well as urban sites in the ancient Near East (Palmer 2001; Betts 2001; Wapnish and Hesse 2003; Hopkins 2003). Lees and Bates elucidate the rationale behind practicing both farming branches saying that:

Since the areas where rainfall is sufficient for agriculture are also in or near zones of natural pasture, we would assume little difficulty in labor allocation between the two modes of production (agricultural and pastoral) in such areas. Here, a high degree of sedentary or short-range transhumant pastoralism is feasible. In fact, it would appear to be quite advantageous (Lees and Bates 1974:188).

As shown in [Chapter 6](#), animal products (meat and milk) provided adequate nutrients (particularly high value protein) required for the essential diet of sedentary populations. If we acknowledge this diagnosis, another question arises: what is the role and function of pastoral-nomads in the overall economic matrix? In other words, what was the nature of the economic relationship between pastoral-nomads and sedentists? This question ought to be addressed in light of the prevailing belief stated by anthropologists, historians, zooarchaeologists and archaeologists, that pastoral-nomads were the chief providers of animal products to sedentary populations (Betts 2001:616). Finkelstein in his book *Living on the Fringe* defines the relationship between pastoral-nomads and sedentary groups as symbiotic: 'In periods of strong urban and rural communities in the north with a healthy society and an efficient government, pastoral people engaged in symbiotic relationship with the settled population. They exchanged their animal products and other desert

goods for grain and other necessary commodities' (Finkelstein 1995:155; see also Finkelstein 1988:337; Finkelstein and Perevolotsky 1990; Schwartz 1995:250).

Dever (1992:88–9; see also Dever 1995b) discussed various socio-economic models that might fit the Early Bronze Age IV in the Southern Levant. He argues that an economic interaction of pastoral-nomads with village and urban society was a common scheme. Rosen (1993, 2003), who discussed pastoral-nomadism in the Southern Levant in several papers argues that another important element of the desert Early Bronze Age system is the clear evidence for longdistance exchange with central Israel. Rosen (2003:757) excavated the Camel site located in the central Negev Desert of Israel. Although animal bones were absent at the site, Rosen concludes that it was occupied by pastoral-nomads who exported pastoral production as well as millstones and beads to the city of Arad. He also states that 'Early Bronze Age pastoral-nomadism in the deserts of the Southern Levant was not merely the expansion of pastoralists into previously under-exploited territories. Rather, it also incorporated the expansion of pastoralism as a system to exploit the "market" potentials of developing urbanism of the Mediterranean zone' (Ibid 2003:758). Edzard (1981:41) studied Sumerian texts dated to the third millennium BCE describing nomad tribes in Mesopotamia. He indicates that pastoral-nomads obtained necessary cereal products, either by aggressive raids on sedentary populations or by exchange of pastoral products. Fall *et al.* (1998:117) state that ancient Near East cities traded with herders in the countryside who provided them with animal goods (Fall *et al.* 1998:117). According to Haiman, 'it is unlikely that a nomadic population could have relied on herding and farming for their livelihood in a desert area such as the Negev, without maintaining economic relations with permanent settlers' (Haiman 2003:248, see also Cavalli-Sforza 1996:56). Rowton has devoted a series of articles to nomadic groups from the second millennium BCE to the second millennium AD (e.g. Rowton 1973, 1974, 1976, 1977, 1981). He repeatedly uses the term 'dimorphic society' to describe society that is 'rooted in close interaction between nomad and sedentary, between tribe and town' (Rowton 1976:14; see also Rowton 1977:181, Rowton 1981:31).

We may deduce that those who advocate the exchange of animal products with agricultural products (e.g. grain) between pastoral-nomads and sedentists also advocate the surplus production designed for trade. Six notes are worth stressing before continuing our discussion:

1. The regional focus of our discussion is the Southern Levant. Levy *et al.* characterize the desert in this region stating that:

'Unlike the vast sand deserts of the Sahara or the Arabian Peninsula, which could be penetrated only with the camel, the deserts of the Levant (Sinai, Negev, southern Jordan) are relatively small geographical areas, not far from the Mediterranean environmental zones, and contain numerous fresh water springs' (Levy *et al.* 2004:71).

Levy's depiction is central for our perception of the Southern Levant environmental context. It underlines two major features: (a) agriculture is feasible and could have been practiced in these deserts; (b) the Levantine deserts are relatively small and moving from the arid region to a contiguous region, which allows agriculture, may take one or two days' walking and do not involve supreme effort.

2. Thus, pure or 'proper pastoral-nomadism' as defined by Khazanov (1984:19) should not be expected in the Southern Levantine geographical context. Examples of proper pastoral-nomads are well known in the anthropological literature. These groups specialize in pastoralism (in regions where agriculture is not feasible) and trade animal goods with sedentary populations. Dyson-Hudson and Dyson-Hudson (1980) provide us with examples of these groups from Afghanistan and Sudan. Legge (1989) studied them in Nigeria, Brown (1971) in Africa, Perevolotsky (1986) in Peru. Rowton (1973) discusses these groups in Iran, Cole (1975) in Saudi Arabia and Shilov (1989) in Eastern Europe. Hence, I do not argue against the validity of proper pastoral-nomadism or of symbiotic relations between pastoral-nomads and sedentists. I do claim that this was not the case in the geographical context of the Southern Levant.
3. Dry farming has been the chief source of grains, a primary source of carbohydrates and an essential nutrient in human diet (Sasson 1998). Thus, it is reasonable to assume that humans would strive to practice agriculture in any region suitable for this activity. It is also important to note that a subsistence economy based on cereals and pastoralism did not require year-round occupation at permanent sites (Marx 1967:20; Finkelstein 1988:199).
4. The anthropological and archaeological literature is rich with data on the practice of agriculture in the Southern Levantine deserts for at least six millennia. Levy (1983, 1992, 1995) and Gilead (1992) provide us with evidence from the Neolithic and Chalcolithic periods, Haiman (1996) and Herzog (1994) from the Early Bronze Age and Cohen (1992) from the Middle Bronze Age. Several archaeological studies of Iron Age sites in the deserts of Jordan, Sinai and the Judean and Negev deserts also support the evidence of agriculture in these regions (Stager 1976; Meshel 1994; Herzog 1994; Bienkowski and van der Steen 2001; Herzog and Singer-Avitz 2004). The Byzantine and Islamic periods provide a large data set on agricultural practices in the Negev Desert (e.g. Rosen and Avni 1993; Haiman 1995; Avner and Magness 1998). Geographers, anthropologists and archaeologists who have been studying the Bedouin economy in the deserts of Sinai, Negev, Judea and Southern Jordan show that Bedouins, while engaged in pastoral-nomadism, practiced dry farming as well. Agriculture prevailed in the economy of the Northern Negev Bedouins as portrayed by El-Arif (1944), Noy-Meir and Seligman

(1979), Marx (1967, 1996), Groen *et al.* (1964), Abu Rabia (1994), Ben David (1990), Falah (1985), and Ginguld *et al.* (1997). According to Ben David (1990:193) during the British Mandate period in Palestine 'the Negev Bedouin cultivated some half a million dunams of land'. Shmueli (1984) supports this information in his study of the Bedouins in the Judean Desert. Moreover, the Bedouins have been practicing rain-fed agriculture in the drier Negev highlands where the average annual precipitation is approximately 100 mm (Eldar *et al.* 1992; Ben David and Orion 1998; Avni 1992). According to Amiran and Ben-Arieh (1963:166–7) dry farming was practiced even farther south where the average annual precipitation is less than 100 mm, in 'pockets of good soil'. Rosen and Finkelstein, who studied the carrying capacity of the Sde Boker region in the Negev highlands, conclude that approximately 100 pastoral-nomads could have subsisted in this area of 200 sq km practicing animal husbandry alone. However, mixing agriculture with animal husbandry would enable 300 people to subsist in the same area. According to Rosen and Finkelstein, horticulture is feasible in the Negev highlands as well (Rosen and Finkelstein 1992; see also Amiran and Ben-Arieh 1963:170). Horticulture is also feasible in the Sinai highlands and is practiced by Bedouins there (Perevolotsky 1981; Perevolotsky *et al.* 1989). According to Kohler-Rollefson, the Huweitat Bedouin in the Transjordan desert combined barley cultivation in the highlands with winter grazing in the eastern desert (Kohler-Rollefson 1992b:12, see also Rollefson and Kohler-Rollefson 1989:85; Betts 2001; Palmer 2001).

5. On the other end of the equation, a sedentary agricultural population, whether urban or rural, was engaged in animal husbandry. The most significant archaeological evidence for that is the faunal remains found in most sedentary sites (cf. Horwitz 1989b; Buitenhuis 1990; Kohler-Rollefson 1992a; Sasson 2005a). The ethnographic literature is also rich with data on animal husbandry practiced in sedentary sites. Hütteroth and Abdulfattah (1977:85) who studied the historical geography of the Southern Levant in the 16th century point out that taxes on small animals are to be found in almost every village and that: 'this may suggest that flocks of small animals (probably goats and sheep) were only kept to meet the direct needs of the villagers'. Thomson *et al.* (1986) provide us with evidence on animal husbandry among sedentary populations from Syria and LaBianca (1995d), Palmer (2001) and Rollefson and Kohler-Rollefson (1989) from Jordan, Dhavalikar (1989) from India, Haaland (1969) from Sudan and Sasson from Israel (Sasson 2006 and see more references there). Even those who claim that pastoral-nomads provided (by exchange) animals products to sedentary populations assent that the latter could have been practicing livestock rearing as well (Finkelstein 1992c:134, Dever 1992:88–9). It is worth noting that the last sentence divulges a self-contradiction: if sedentists

have been exploiting livestock, why would they acquire animal products from pastoral-nomads?

6. By articulating that pastoral-nomads in the Southern Levant were not dependent on sedentary settlements for cereal provisioning and that sedentary societies were certainly not dependent on pastoral-nomads for pastoral products I do not argue for a nonexistent relationship between these populations. I assert that the common household, the pastoral-nomadic and the sedentary-farmer, were all self-sufficient. Both households subsisted on agriculture as well as on animal husbandry and were not dependent on each other. Pastoral-nomads and sedentists living in neighboring ecological regions communicated socially or rather 'diplomatically' to exchange vital ecological information (water resources that have dried or have flowed for instance). They most likely maintained random exchange of goods, though this definitely does not imply an organized trade or a market economy.

On the Validity of the Analogy to Contemporary Pastoral-Nomads

Nothing is so misleading in ethnographic accounts as the description of facts of native civilizations in terms of our own (Malinowski 1922:176)

The second reason some anthropologists think conventional economics applicable to all economies is—to speak bluntly—due to their imperfect understanding of economic theory and its concepts (Dalton 1969:67).

What led scholars to the concept that pastoral-nomads maintained a symbiotic or dependent relationship with sedentary populations in ancient times? What led scholars such as Finkelstein and Perevolotsky (1990; Finkelstein 1988), Dever (1992), Herzog (1994), Horwitz (1989b), Bienkowski and van der Steen (2001) and LaBianca (2003) to assert that pastoral-nomads have striven to settle down and relinquish their nomadic strategy whenever possible? It is most probably that the reason for this conception is the abundant ethnographic sources and anthropological studies of contemporary pastoral-nomads recounting these forms of relationships and processes (Kohler-Rollefson 1992b:11). Symbiotic relationships between pastoral-nomads and sedentists were accentuated by prominent anthropologists such as Lees and Bates (1974; see also Bates and Lees 1977), Barth (1969), Spooner (1971), Khazanov (2001) and Rowton who provided examples from Iran, Turkey and Transjordan (Rowton 1973, 1976, 1977, 1981). Emanuel Marx, who extensively studied the Negev Bedouins, argued that this pastoral-nomadic group lived in a symbiotic relationship with the sedentary society (Marx 1977:347, 1984b:3, 1992:257).

The process of sedentarization among pastoral-nomadic groups was also discussed extensively in the anthropological literature. Salzman (1980)

discussed this phenomenon among the Sinai Bedouins, Ben David (1982, 1990), Marx (1984b) and Meir (1986) studied this among the Negev Bedouin and Cole (1975) who discussed this process among a 'pure' nomadic tribe in Saudi Arabia. The evidence for symbiotic relationships and the tendency of pastoral-nomads to voluntarily sedentarize is vast indeed. However, projecting these economic strategies and processes to ancient societies should be viewed with caution (Avni 1992; Haiman 1996).

Anthropological studies as those presented above focus by nature on contemporary societies, some of them located in developing and modern countries (I use the term 'contemporary' when referring to the pre-modern and modern periods, i.e. the past two or three centuries). Bar-Yosef and Khazanov (1992:3) have already stressed that most of our knowledge on pastoral-nomads comes from data collected in the 19th and 20th centuries. As much as we would like to believe that these pastoral-nomads preserved all their traditional economic strategies we must recognize that the economic context of the last centuries is obviously different to that of the Bronze and Iron Age. Even if we go back in time beyond the industrial revolution, the economic context is still considerably different from ancient times. As Wilson (1941), Polanyi (1944), Dalton (1969, 1971a) and others have stressed, the analogy of 'peasant' (traditional) economics and 'primitive' (ancient) economics is feeble. This also entails the analogy to economic strategies among pastoral-nomads. The list of factors that discerns ancient economy from pre-industrial and industrial economies is long and diversified: ancient economy lacks money as well as developed vehicles and transportation infrastructure, strong central authority with competent access to remote peripheries, tempting opportunities for lucrative labor (see examples in Cole 1975; Brawer 1990; Kressel and Ben David 1995 and Marx 1984a), and other developing technologies (e.g. electricity, water pumps). These features facilitated the pastoral-nomads-sedentists' relationship and accelerated processes of trade and sedentarization. As I stressed earlier, the notion of market economy in the Bronze and Iron Age is debatable. The lack of concrete archaeological evidence for marketplaces in the Bronze and Iron Age (as opposed to abundant evidence coming from the Classical period and onward) weakens the market economy notion and sharpens the differences between the economic characteristics of the Bronze and Iron Age and the periods following it.

Many pastoral-nomadic groups have settled down in the past two centuries. However, the causes listed by anthropologists to explain this process were either absent in ancient economies or were not as significant as in the past few centuries. Amiran who studied the sedentarization process among the Negev Bedouins attributes modernization and technology as a primary factor in this development (Amiran and Ben-Arieh 1963:169; Amiran 1965:203–205). Shmueli also indicates that an industrial economy was one of the causes of sedentarization: 'When industrial economy had spread to the margins of settled areas thus influencing social set-up and the Bedouin economy, it was

apparent that revolutionary change had occurred in the frontier' (Shmueli 1984:18). According to Shmueli, wage labor, more profitable income opportunities and the increased access to employment centers have weakened the importance of herd raising and were major factors in the sedentarization of pastoral-nomads (Shmueli 1984:32-3, see also Marx 1984b:3; Ben David 1990:193; Peters 1990:40). Abu Rabia states that: 'formerly, nomadism for pasturing was the main source of livelihood and forged a strong dependent relationship between the Bedouin and their natural surroundings. The development of new sources of employment reduced the Bedouin's dependence on the environment and on livestock rearing as the major source of sustenance' (Abu Rabia 1994:12). Salzman points out strong central political authority, improved technology and wage labor as factors in pastoral-nomads' sedentarization (Salzman 1980:15-16). According to Marx, two major forces, which are often interlocked, pulled the carpet from under the traditional economic lifeway of pastoral-nomads: population growth among these groups (as a result of improving health conditions) and a strong central authority (Marx 1973:94, see also Shmueli 1984:31). Falah (1983:7, 45), Levy and Holl (2002:110) and LaBianca (2003:121) explain that central governments established well-guarded national borders that impeded the traditional nomadic long-distance migration. This development forced them to modify their economic strategies (see also Ben David 1990:193; Hopkins 1993:205). I shall demonstrate how analogies to contemporary pastoral-nomads can be misleading. Cole (1975) studied the El-Murrah Bedouins situated in Saudi Arabia. The El-Murrah were pure nomads who worked in the oil fields discovered in their territory in the 1930s, a development that eventually led to their sedentarization. One may conclude that as the El-Murrah, pure camel nomads, have chosen to settle down, and that pastoral-nomads in antiquity went through a similar course of action. However, central factors in the El-Murrah case are missing in antiquity. These factors were discussed above and include an industrial economy, vast opportunities for wage labor and income that is more profitable, modern transportation means and a strong central authority (for an additional example see Levy and Holl 2002).

In sum, the list of factors affecting pastoral-nomads in the past several centuries encompass modernism (i.e. enhanced health, transportation and other modern technologies), accessible lucrative labor, industrial and urban centers dependent on external agricultural production, all-purpose money, strong central governments, defined political borders and intensified population growth. These features generated an increasing demand for agricultural and livestock products, improved communication and trade facilities between urban centers and pastoral-nomads and eventually coerced the latter into settling down. It is worth noting that these factors are also missing from other economic dynamics in the Bronze and Iron Age. Thus, the analogy between contemporary economic mechanisms and those in antiquity is feeble as well. There is no doubt that ethnography is an important source for

our understanding of ancient populations. However, it should be used with caution, especially when modern forces may alter the picture. The premise of sedentarization of nomads based on this analogy should therefore be reconsidered.

The Strategic Preference of Nomadism

If we acknowledge that pastoral-nomads in the Southern Levant practiced animal husbandry as well as agriculture and thus were not dependent on sedentary societies, the question of their role in the general economic system is now begging to be addressed with more urgency. Another question arising is why have they selected a nomadic strategy? First I will address the second question: why nomadism?

Those who claim that pastoral-nomads traded with sedentary societies often claim that nomadism was a temporary episode and to some extent coerced. They also argue that pastoral-nomads would choose to settle down when circumstances allowed it. According to Dever, the collapse of the socio-economic system in the Early Bronze Age IV in Palestine led some of the city dwellers to shift to pastoral-nomadism (Dever 1995b:295; see also Harrison 1997:18-24). Herzog determines that the decline in the environmental conditions in the 10th century BCE forced some of the Beer-Sheba valley inhabitants to revert from subsistence economy to pastoral-nomadism (Herzog 1994:145). In another paper Herzog and Singer-Avitz say: 'The demographic decline of the settled population indicates that part of the rural occupants must have been forced to shift to a nomadic life' (Herzog and Singer-Avitz 2004:232, see also Schwartz 1995:250). We may deduce from Dever, Schwartz and Herzog's conclusions that since environmental or political decline coerced populations into shifting to nomadism, this strategy was not a favorable selection (Finkelstein and Perevolotsky 1990). LaBianca (1995d:215), in his discussion of the history of Tel Hesban, claims that in periods of political peace and prosperity the site was inhabited by groups of pastoral-nomads (for the same argument regarding the Northern Negev settlements see Finkelstein 1992b:159; Jasmin 2005:144). Bienkowski and van der Steen (2001:40) conclude that groups of pastoral-nomads who occupied Edom (southern Jordan) from the 12th through the 10th century BCE began settling down in the 9th century and that the 'pax Assyriaca' intensified the process of sedentarization by the late 8th century BCE. According to Finkelstein, Arad of the Early Bronze Age and Tel Masos of the Iron Age were towns established by desert nomads (Finkelstein 1990, 1995:20-26; see also Miroshedji regarding Yarmuth in the Early Bronze). In a synthesis of data from archaeological surveys and excavations coupled with ethnographic data, Finkelstein concludes that: 'at the end of the 13th century BCE, the socio-economic and political tides turned, and conditions became favorable for groups of pastoralists to settle down' (Finkelstein 1988:345, see also Hopkins 1993:210; Younker 2003:157).

Was pastoral-nomadism less attractive for Bronze and Iron Age populations? Were those populations forced to shift to nomadism in order to cope with deterioration of political or environmental conditions? Did they choose to settle down when these conditions improved once again? I argue that these premises should be rejected and that pastoral-nomadism was a strategic preference rather than imposed one.

Before elaborating on the strategic preference of pastoral-nomadism, I shall provide two possible sources for these misconceptions. The first source was discussed in the preceding section; abundant ethnographic sources showing the sedentarization of contemporary pastoral-nomads (Amiran and Ben-Arieh 1963; Salzman 1980; Ben David 1982; Falah 1985; Meir 1986; Rosenberg 1998; Bradburd 2001; Khazanov 2001). However, as discussed above, the process of sedentarization in contemporary times and in antiquity is not analogous. The second source for these misconceptions may be called 'sedentary discrimination' or a Western cultural mindset. It is reasonable to assume that scholars who are sedentists and are descendants of many generations of settled people have difficulty grasping the idea of a nomadic lifestyle and non-permanent housing (Redman and Kinzig 2003:4–5). The sedentary prejudice against a nomadic lifestyle may be demonstrated through Kohler-Rollefson's discussion on the emergence of nomadic pastoralism in early Jordan: 'As it became difficult to produce animal products locally, those who took the initiative and *gave up the comforts of a sedentary existence* [my emphasis] to raise goats were able to obtain their fair share of grain or vegetable products in exchange' (Kohler-Rollefson 1992b:16). It appears that scholars, ingrained in modern sedentary cultures, view nomadism as an uncomfortable and unfavourable livelihood. From this point of view, the path to concluding that nomads strived for settling down is apparent.

Pastoral-nomadism was a strategic preference taken by some elements of the population which enabled them to exploit marginal ecological niches (Cribb 1991:15; Porter and Marlowe 2007:65). This strategy enabled them to avoid competition with other groups who chose to settle down. It has prominent advantages over occupying permanent settlements (that will be discussed below) which makes it, to my judgment, the most successful survival subsistence strategy. Legge who studied the Wodaabe pastoral-nomads tribes in Niger explains that mobility is the most obvious response to the temporally and spatially variable resources of the Sahel of West Africa. Legge points out that mobility avoids overgrazing difficulties, disease and drought and it maximizes the effective use of limited resources (Legge 1989:82–3, see also Widstrand 1975:150; Smith 1978:85; Franke and Chasin 1980:41–2; Szuter and Bayham 1989). Ingold also shows that mobility is an essential means of coping with environmental unpredictability and that this flexibility is not available to the sedentary pastoralists (Ingold 1980:247, see also Noy-Meir 1974:202; Lees and Bates 1974:188; Redman and Kinzig 2003:11). Ochsenschlager (1993:33) who conducted an ethnographic study of Bedouins in southern Iraq points out that

the fertility rate among Bedouin sheep is significantly higher than that of the villagers' sheep. He attributes this fact to the migratory lifestyle of the Bedouins which appears to be a necessity for the health of their flocks. Hesse (1995a:205) notes that a nomadic lifestyle isolated animal herds from one another. This segregation minimized the spread of disease among the nomads' flocks. These flocks were well adapted to their local habitats thus this isolation also reduced gene flow among domestic flocks. Bradburd (2001:135) who studied the history of pastoral-nomads in Iran states that mobility coupled with their ability to exploit marginal and hostile environments makes nomads more difficult to control than many sedentary populations. He explains that for the 'nomadic pastoral community, flight has a far "lower cost" than it has for sedentary peoples who must, in flight, abandon significant investments in houses, improved agricultural land, or irrigation works' (ibid:136, see also LaBianca 2003:117). Marx (1973) also indicates that for Bedouins, the economic benefit in continuous holding of a territory does not compare with the burden of being restricted by a central authority, military service or tax fees. Khazanov (1984:70) stresses that nomadism enabled pastoralists to occupy the dominant position in many ecological zones and to utilize these zones economically over a long period. Noy-Meir (1976:102) analyzed the ecology of grazing management among the Negev Bedouins. He shows that their decision-making in regard to mobility of their flocks in time and space is definitely based on ecologic and economic logic. Marx (1977:345-7), who discussed the ecology of pastoral-nomads, notes that we need not consider the nomads' campsite as their habitat. Their 'area of subsistence' is in fact much larger and the strategy of widely ranging nomadism enables them to obtain eventually sufficient pasture and water resources for their flocks. Abu Rabia explains that seeking seasonal pasture is only one reason for nomadism. Mobility also enables pastoral-nomads to escape from a wide range of impending risks such as livestock pests, diseases, competition with other groups and conflicts with central governments who aim to tax them or recruit them for military service (Abu Rabia 1994:12, see also Dyson-Hudson and Dyson-Hudson 1980:17-18; Hopkins 1993:205). According to Jochim (1981:148) mobility helps to avoid risks and reduce stress; it is 'a strategy for redistributing people in the environment'. He also highlights an additional advantage in mobility: collecting information. Namely, nomadism allows pastoralists to gather and redistribute information on the state of resources such as water and pasture (ibid:207; see also Spicer 2005:2173).

Nomadism is normally tied with pastoralism. Barth (1973) has suggested that livestock is a better investment than agricultural land. I do not attempt to point out all the virtues of pastoralism though we should highlight two significant qualities that ties livestock husbandry with the survival subsistence strategy. The first trait will be discussed briefly since it is well recognized in the literature. Pastoralists normally breed a variety of species for consumption as well as labor. A range of livestock—cattle, sheep, goat, pig, donkey and

camel—secures a variety of products and services and reduces the risk of wholesale loss through disease. A range of species also contributes to spreading the impact of resource exploitation widely enough so that it is sustainable (Lees and Bates 1974:188; Widstrand 1975:150; Smith 1978:85; Tchernov and Horwitz 1990:207–208; Cribb 1991:27–8; Halstead 1996:24; Reitz and Wing 1999:253). I shall elaborate on the second trait of livestock husbandry. Quick recuperation and reproduction rates among most livestock were most likely a substantial incentive to nearly all ancient and traditional economies that subsisted on animal husbandry. Dahl and Hjort point out that a herd of goats might double its number after less than three years (Dahl and Hjort 1976:103, see also Dahl 1979:42; Swift 1973:73; Russell 1988:73–4; Cribb 1991:29; Hopkins 1993:207). Abu Rabia (1994:113) tracked the reproduction rates among Bedouin livestock. He reports that a mixed flock of sheep and goats in the Northern Negev doubled its size in two breeding cycles. Ben David (1982:169) who studied the Negev Bedouins provides us with a factual illustration—a herd of 180 caprines reduced to 50 due to poisoning. In a period of three years the herd recovered to its original size (i.e. from 50 to 180).

Further evidence for the value of pastoralism as a survival subsistence strategy is illustrated by the fact that groups who do not rely on pastoralism as primary subsistence source keep a small amount of livestock as ‘life insurance’ for times of distress. A perceptible demonstration of this strategy is brought by Abu Rabia (1994:97–103). Sami, a Bedouin tribesman from the Northern Negev, Israel, was tempted to establish a new ‘modern’ business. He sold his sheep flock, took a loan from the bank and purchased a truck so he could work as truck driver. Sami did not manage his business very well and he was forced to sell his truck. He was broken financially and morally. Sami made use of several sheep, he received as a gift and some his wife owned, as breeding stock and after two years of intensive care and constant work, the flock returned to its original size before the truck transaction. Rabinowitz who studied the economy of the Sinai Bedouins says: ‘It seems that the strategy of the 1970s—keeping small herds as nuclei for growth in case of future hardship—was also present in Sinai in the nineteenth century, and possibly earlier’ (Rabinowitz 1985:223, see also Perevolotsky 1986:290). Finkelstein and Perevolotsky (1990:72) note that a small herd was kept as a reproduction core and that ‘keeping some animals from propagation gives the family an easy and fast shift back to pastoralism if conditions change’. Salzman stresses that a core herd was kept even when it did not contribute to the household economy or even when it was a source of loss to the household (Salzman 1980:7, see also Abu Rabia 1994:114). Marx concludes that although the Negev Bedouin obtained a larger part of their livelihood from cultivation than from herding they ‘could not survive without their herds because of frequent crop failure’ (Marx 1977:344, see also Marx 1967:26). The real life incidents as presented by Ben David (1982) and Abu Rabia (1994), together with the last two comments by Salzman and Marx, demonstrate clearly the significance of pastoralism as a component in

the survival subsistence strategy. Moreover, keeping a breeding stock even when the subsistence economy was based on agriculture, wage work or other resources did not require hard labor. Maintaining livestock had the advantage of 'cheap labor available to most households, the ability to utilize cheap inputs (grazing on marginal lands) and the small investment in equipment' (Ginguld *et al.* 1997:587, see also Marx 1967:94; Russell 1988:83; Khazanov 1984:32).

The advantages of nomadism as a long-term strategy could be summarized as follows: it enables a balanced utilization of natural resources and preserves an ecological equilibrium (e.g. water, pasture). It avoids competition with other groups and the burden of central authority (e.g. tax, military service). Nomadism probably enables the most effective escape from diseases or insects that endanger livestock or pasture and it establishes a mechanism that copes with environmental hazards (such as drought that affects water resources as well as pasture availability).

If pastoral-nomadism was a successful strategy, the question to be addressed is why it was not maintained by larger segments of the population. It would be reasonable to assume that the typical pastoral-nomads were not the only ones engaged in nomadism. The following paradoxical formula probably best portrays pastoral-nomads and sedentists in the Bronze and Iron Age: the typical pastoral-nomads in the Southern Levant had permanent camps and sedentists practiced nomadism. Pastoral-nomads were engaged in animal husbandry as well as rain-fed agriculture while sedentists practiced agriculture as well as animal husbandry. Ingold (1984:7) asserts, for instance, that sedentists could occasionally be more mobile than pastoral-nomads. The paradoxical scheme can be demonstrated through ethnographic sources. Rollefson and Kohler-Rollefson (1989:85) studied the Marrai'e Bedouin who practice agriculture as well as pastoralism and inhabit two villages in southern Jordan (Suweimra and New Suweimra). On first glance, we may consider them sedentists and archaeologically, these two villages would be categorized as two sedentary sites. However, during the autumn and winter, most of the Marrai'e leave their villages to become nomadic. According to Kohler-Rollefson (1992b:14–15) around 40% of the buildings in Suweimra belonged to pastoral specialists who were tent-dwellers during the entire year and during the summer they pitch their tents in the vicinity of the village, frequently changing their campsites. She adds: 'To confuse matters further, many permanently settled inhabitants had pitched tents along their stone houses and used these for entertaining guests and for performing certain household duties in the traditional Bedouin way' (Kohler-Rollefson 1992b:15, for similar case occurring in the Zagros mountains see Prag 1985:83–4). In other words, it is most likely that pastoral-nomadic groups exploited and seasonally occupied regions normally inhabited by sedentary population. According to Hütteroth and Abdulfattah (1977:48–50 and map 1), pastoral-nomadic population in the Southern Levant of the 16th century CE could be found in all regions inhabited by sedentary populations. Additional examples of the terminological paradox

come from the Negev Bedouin. Ben David (1988:109) portrays Bedouin families that were year-round tent dwellers. On first glance, we may categorize them as nomads; however, they practice agriculture and reside in a permanent campsite. In the low season, when pasture decreases, a mobile camp would diverge from the permanent camp, moving to distant pastures for their livestock. As has been shown above, sedentists in the Southern Levant were engaged in animal husbandry as well as agriculture, thus they could be considered pastoral-nomads as well. We may conclude this section using Wapnish and Hesse's words: 'It is important to recognize that sedentism does not necessarily mean less movement than nomadism, only the pattern of movement is different' (Wapnish and Hesse 1991:24).

Why did people settle down? This topic requires an elaborate discussion, which will not take place here. Nonetheless, one advantage of sedentism related to animal husbandry is worth noting. The biblical story tells us the following: 'And David said unto Saul: "Thy servant kept his father's sheep; and when there came a lion, or a bear, and took a lamb out of the flock, I went out after him, and smote him, and delivered it out of his mouth; and when he arose against me, I caught him by his beard, and smote him, and slew him"' (1 Samuel 17:34-35). Predators, therefore, could have been a major reason for groups engaged in animal husbandry to settle down, establish a safe environment surrounding the settlement and prevent predators from invading their turf.

To conclude, transhumance was a successful, if not the most successful, survival subsistence strategy in the Bronze and Iron Age. Most likely, it was prevalent among large sectors of the population, possibly larger than the sedentary sector. Archaeology is misleading due to the disproportional amount of evidence coming from sedentary sites compared to nomadic sites.

Hitherto I have addressed the question of why nomadism is a favorable strategy. The question that still needed to be addressed is: what is the role of pastoral-nomadism in the entire economic system or, in other words, why has pastoral-nomadism evolved?

'Homo sapiens sedentus' and 'Homo sapiens nomadus'

...the native practitioner recognizes intuitively what the Western analyst finds so hard to grasp, namely that people act on their surroundings from within. From the outset, they are embedded in ties to the earth and to the manifold beings that spring from it: they are already 'with' their environment prior to doing anything 'to' it (Ingold 1996:23).

In this sub-chapter, I shall exploit the idea of parity between human behavior and some of their operations and responses to other organisms (animals and plants for instance) in natural ecosystems. I will argue that sedentists and particularly pastoral-nomads underwent a process of adaptation to a habitat and thus would be reluctant to relinquish it.

Pastoral-nomadism evolving from agricultural societies has been extensively cited in explanations of animal domestication and the origin of pastoralism in different regions of the old world (cf. Levy 1983; Khazanov 1984; Shilov 1989; Keswani 1994; Schwartz 1995; Simmons 1995; Harris 1996; Ingold 1996; Cavalli-Sforza 1996; Uerpmann 1996; Zohary *et al.* 1998; Diamond 2003; Leach 2003; Bleed 2006; Zeder 2006a). Levy (1992:66), in his study of transhumance in the Northern Negev stated: 'While the decade of the 1980s has been characterized by an emphasis on post-processual models of human behavior which focus on symbolic, structural and critical archaeologies, it will be argued here that an ecology-based study is the most appropriate one for investigating man/animal relationships through time'. This approach is adopted here. By using models and concepts from human behavioral ecology (Rappaport 1969; Smith 1992a, 1992b; Winterhalder and Smith 2000), the following discussion will provide a broader perspective on pastoral-nomadism as an ecological adaptation and a long-term strategy.

Charles Darwin, in the introduction to *The Descent of Man*, asserts that 'man must be included with other organic beings in any general conclusion respecting his manner of appearance on this earth' (Darwin 1871:1, see also page 45). Jochim (1981:3) discussed cultural behavior in an ecological context and noted that 'humans are animals. They do interact with the natural environment, and their behavior does seem to show some patterning in relation to patterns in the natural environment'. He stresses the contribution of animal behavior to understanding ecological anthropology: 'A major input into ecological anthropology consists of generalization drawn from studies of animal behavior. Territorial behavior by other animals might be used to shed some light on the determinants and structure of human land use' (Jochim 1981:166). Employing methods of animal behavioral ecology to human behavior is invoked in the current literature of evolutionary anthropology (Odling-Smee *et al.* 2003; Laland *et al.* 2004; Laland and Brown 2006). Laland and Brown (2006:98) state for instance that: 'humans continuously construct and reconstruct important components of their selective environments. In this respect, humans are no different from other organisms.' Considering animal behavior is a plausible source for understanding human behavior, an additional premise should be introduced: the supreme biological goal for humans (as well as for animals) is to secure their long-term survival by propagating their genes into the next generation (Simpson 1949:243; White 1959:36; Ayala 1974:346; Ingold 1986:22). Theodosius Dobzhansky, evolutionary biologist and geneticist, who studied the population genetics of fruit flies, defined this impetus as adaptedness:

It is self-evident that any living species, at least any species not about to become extinct, has a valid set of solutions for certain basic ecological, or biological problems. It must secure food to replenish its energy store, must have a place to live, and a method to reproduce and thus to perpetuate its genes in succeeding generations. Possession of a valid set of such solutions is called adaptedness (Dobzhansky 1974:323; see also Jochim 1981:14).

The next premise to be introduced was pointed out by Darwin (1859:86) in *On the Origin of Species*. He noted that diversification is a key factor for the survival of species: 'in the general economy of any land, the more widely and perfectly the animals and plants are diversified for different habits of life, so will a greater number of individuals be capable of there supporting themselves'. Jochim (1981:45; see also Redding 1988) advocates this notion saying that 'two different species cannot occupy the same niche for very long. For them to do so would mean that they had identical requirements and thus would compete for everything. In such a situation, one would eventually out-compete the other and prevail; the other would become extinct in that habitat or alter its niche'. In other words, a limited population is able to occupy a certain ecological niche. However, if this population is diversified and segments of it are adapted to one habitat while other segments are adapted to a different habitat, a greater number of individuals will be capable of supporting themselves (Holling and Gunderson 2002, 83–84). Barth (1956) provides us with an excellent example of the advantages of diversification for sustaining larger human populations. Barth studied the area of Swat, north Pakistan, which is occupied by three ethnic groups; one group is sedentists (Pathans), the second practice farming and transhumance (Kohistanis), and the third consists of mainly nomadic herders (Gujars). The Kohistanis were the original inhabitants who occupied the total region. Swat was then invaded and populated by the other two groups. The geography of the Swat area consists of two river valleys separated by high plateaus. Barth explains that 'each group exploits only a section of the total environment, and leaves large parts of it open for the other groups to exploit. This interdependence is analogous to that of the different animal species in a habitat' (Barth 1956:1079; for similar case from Sudan see Haaland 1969).

The idea outlined here is that an analogy can be drawn from two animal species occupying a habitat to two human 'sister-species': the '*Homo sapiens nomadus*' and the '*Homo sapiens sedentus*'. I certainly do not claim to have discovered two new hominin species or do I claim that sedentists and nomads are different species in the biological sense (Darwin 1859:38–48; Mallet 1995; Mayr 1996) since obviously they are able to reproduce with each other. Nonetheless, we may regard these two groups as diverse, ecological species, with assorted sets of solutions and adaptations. Franke and Chasin (1980:45) provide us with an additional example of humans as ecological species. In the 12th and 13th centuries CE, groups of the Fulani, pastoral-nomads from the Sahel, West Africa, migrated eastward. They migrated through regions inhabited by other existing social groups, though they posed no threat to them. They did not enter into competition for land with the local agriculturalists, since like their ancestors, they were able to make use of areas that were of no value to the farmers. The examples above demonstrate that a geographical area would sustain larger groups if these groups were diversified and capable of exploiting different ecological niches. Diversification would also secure a long-

term survival.

Despite the analogy between plants and animals and human behavior, I do not disregard the fact that humans are significantly more capable of cognitive decision-making than other organisms. Zeder portrays this central disparity saying that humans 'are capable of modifying their behavioral repertoires through "trial and error, observation, and imitation". That ability enables humans to rapidly develop behavioral strategies aimed at meeting consciously recognized needs' (Zeder 2006a:106, see also Jochim 1981:18–19). On the other hand, we should note that the behavior and ecological adaptations of other organisms is a result of gradual co-evolutionary processes based on mutation-induced behavioral and morphological change (Bleed 2006:8). It would be reasonable to assume, therefore, that pastoral groups, possibly after a series of trials and errors, developed behavioral mechanisms designed to exploit marginal areas through transhumance strategy. Most scholars studying pastoralism concur that pastoral-nomads inhabit areas that are normally marginal. Rosenberg (1998:659) refers to this idea, saying that 'given a system of territories and continuing population pressure, it is inevitable that a certain percentage of the population will develop into holders of relatively marginal territories or even nonterritorial floaters'.

In a recent study conducted by Porter and Marlowe (2007:65), using global remote-sensing data, they demonstrate that pastoralists occupy less productive habitats than agriculturalists. Spooner (1971:205) asserts that 'the habitat of nomads—which may be an extensive area, or just a niche in an area which is also occupied by non-nomads—is always marginal, at least in relation to the habitat of their non-nomadic neighbors' (see also Cavalli-Sforza 1996:56; Smith 1978:85; Betts 2001:615). It would be difficult to determine whether pastoral-nomadism emerged as result of a cognitive or non-cognitive choice or a combination of both. Apparently, the experiment was declared a success and pastoral-nomadism evolved into a widespread subsistence strategy (see discussion in the preceding sub-chapter).

Darwin (1859:86) defined how diversified species have evolved: 'these allied species have descended from a common parent; and during the process of modification, each has become adapted to the conditions of life of its own region, and has supplanted and exterminated its original parent and all the transitional varieties between its past and present states'. While the quest for the origin of domestication and pastoral-nomadism is not the central theme of this work, I shall discuss briefly the two common scenarios in light of Darwin's views. Before continuing, I shall review the premises outlined above: (a) homologies between humans and other organisms can be observed; (b) the chief goal of humans is perpetuating their genes; (c) in order to achieve this goal, diversification of species occurred; (d) man has subdivided into several sister-species exploiting diverse ecological niches. Consequently, the goal of gene perpetuation is achieved. In our model, two diversified sister-species namely '*Homo sapiens nomadus*' and '*Homo sapiens sedentus*' have descended

from a common parent.

One of the most enduring challenges is the question, who the common parent was? Two possible scenarios may have occurred. In the first, the common parent was a hunter-gatherer that was subdivided in a gradual process into two groups. The first group, following plant domestication, modified its adaptations and settled down while the second, following animal domestication, modified its adaptations and became pastoral-nomadic. As a result, the common parent, the hunter-gatherer, was supplanted for the most part by the newer species. In the second scenario, the common parent was an agricultural sedentary population. A founder species, the “*homo sapiens nomadus*”, diverged from the common parent that has not been supplanted in the process. The first scenario is compatible with Darwin’s scheme. It is possible, though difficult to attest, that animal domestication occurred among hunter-gatherer groups yet did not leave archaeological traces (Davis 2005). The second scenario, extensively invoked in explanations of the emergence of pastoral-nomadism (see references above) and supported by archaeological evidence (particularly paleobotanical and zooarchaeological finds) also has an ecological rationale.

We may make use of recent models proposed by evolutionary biologists to address the evolution of pastoral-nomadism. Odling-Smee *et al.* (2003:44–50) exhibit a model they define as ‘niche construction’ and suggest that organisms, through their metabolism, activities, and choices, modify ecological niches (see also Laland *et al.* 2004). They also define counteractive niche construction as occurring when organisms either disturb their environments or relocate in space to neutralize some prior change in selection pressures (see also Laland and Brown 2006:99). We may assume, therefore, that geographical relocation was a choice made by some of the sedentary groups to neutralize changes in selection pressures. These groups have moved to the ecological margins of their former habitat and, through niche construction coupled with other processes (physiological for instance), they became adapted to the newly exploited niche. The brief discussion on the origin of pastoral-nomadism demonstrates that regardless of whether ‘*Homo sapiens nomadus*’ diverged from hunter-gatherer groups or from sedentary groups he had to engage in niche construction in the new habitat (this applies to the ‘*Homo sapiens sedentus*’ as well). According to Laland and Brown (2006:95): Humans as other organisms,

do not just build environmental components, but regulate them to damp out variability in environmental conditions. Beavers, earthworms, ants, and countless other animals build complex artifacts, regulate temperatures and humidities inside them, control nutrient cycling and stoichiometric ratios around them, and in the process construct and defend benign and apposite nursery environments for their offspring.

The ‘*Homo sapiens nomadus*’ relocating to a new habitat had to maintain active, complex, and formative interactions with its surroundings. That is to say, niche construction in a pastoral-nomadism context would have been for

instance, managing pasture and water resources to protect them from over-exploitation, building seasonal camps and building dams in wadis for collecting rainwater. Gaining knowledge of the natural resources available, the pastoral-nomadic group would regulate its population size to adjust to the carrying capacity (see above the discussion on population size). LaBianca (2003:117) notes that unlike sedentists, pastoralists rely to a greater degree on their knowledge of natural pastures and watering places for year-around access. It is most likely that the 'nomadus' went through much trial and error and a learning curve before reaching the knowledge that enabled him to damp out variability in environmental conditions and enhance fitness (Redman 2005). Furthermore, adaptation mechanisms of the 'nomadus' to a new niche, involved adjustments and modifications in cultural, sociological, and ideological behavior as well as in appearance and physiology (Wallace 1870; Spooner 1971; Jochim 1981; Little 1989; Keswani 1994; Simmons 1997; Leach 2003; Odling-Smee *et al.* 2003; Bleed 2006). Analysis of the sociological and cultural modifications is beyond the ecological scope of this essay. These issues have been frequently discussed in the anthropological literature (e.g. Ben David 1982; Fratkin *et al.* 1999; Salzman 1980 and see additional references there).

I shall elaborate on the physiological and morphological modifications generated through adaptation processes. It is well known that humans in the late Pleistocene, as other organisms in evolution, went through considerable changes in stature and physiology (for further discussion and references see Leach 2003:350–5). Three examples, all attributed directly to pastoral-nomads in the ancient Near East, will be demonstrated here. Cook (1978) has pointed out that people with persistence of the intestinal enzyme lactase at high concentration into adult life (PL) would have been at a distinct advantage compared to populations with hypolactasia. They would have the ability to absorb not only lactase but also other fluids; in contrast, those with adult hypolactasia, a failure to absorb lactase, would have suffered colic and diarrhoea. Increased survival of groups with PL would thus be anticipated. Holden and Mace (1997) have tested the lactose digestion capacity among 20,000 individuals worldwide. They point out a strong correlation across cultures between the presence of the genes for lactose absorption and a history of dairy farming; this may indicate that dairying created the selection pressures that led to genes for lactose absorption becoming common in pastoralist societies (see also Odling-Smee *et al.* 2003:342–3; Laland and Brown 2006:96).

Chaplin (2004) and Jablonski (2004) have tested the relationship between skin reflection and seasonal ultraviolet radiation (UVR) levels and other environmental variables. They combined UVR data recorded by satellite with environmental variables and data on human skin reflection in a geographic information system (GIS). Their conclusion is that skin pigmentation of indigenous human populations shows a remarkable regularity in its geographic

distribution. Darker skins occur in more tropical regions and lighter skins in temperate regions (Jablonski 2004:601; Chaplin 2004:300).

McCance *et al.* (1974) compared Negev Bedouin males with Jewish male students. They sought to address the question whether, physiologically speaking, the Bedouins are likely to be better adapted for desert life than other ethnic groups. Although they found no significant evidence for this hypothesis, they indicate that the Bedouins certainly tended to produce less sweat than the Jewish students (McCance *et al.* 1974:269). Reduced sweating is clearly a thermoregulation mechanism and should be attributed to a physiological adaptation to desert habitat. Thus, there is no doubt that '*Homo sapiens nomadus*' relocating to marginal regions went through adjustments in morphology and physiology. '*Homo sapiens sedentus*' too, went through modifications, adapting his own habitat (Leach 2003; Bleed 2006; Twiss 2007). Moreover, switching habitats for these 'species' was not as simple as we may presume. Studies of sedentarization of the pastoral-nomads show that physiological adaptations to their original habitat have been an obstruction when they moved to a sedentary habitat. Murray *et al.* (1980) examined two groups of Turkana, pastoral-nomads in Eastern Africa. One group has settled down while the other continued practicing pastoral-nomadism. They found that episodes of fever, symptomatic infection with malaria and brucellosis, molluscum contagiosum and common warts, episodes of diarrhoea, and serological evidence of infection with *Entamoeba histolytica* increased significantly in the settled Turkana (see also Barkey *et al.* 2001). Health problems due to change of diet and other factors also occurred among the Gourma pastoral-nomads who settled in Mali, West Africa (Chabasse *et al.* 1985) and among the Ariaal and Rendille who settled in Kenya, East Africa (Fratkin *et al.* 1999 and see more case studies there).

The complexity in the adaptation of '*Homo sapiens nomadus*' to a sedentary environment (and the '*Homo sapiens sedentus*' to a nomadic environment) may also be demonstrated through the 'adaptive lag'. The adaptive lag is defined as the lag between changes of an ecological niche to a slower change of the organism adapting to it (Smith *et al.* 2001; Leland and Brown 2006). In other words, the rate at which '*Homo sapiens nomadus*' adapted to a new sedentary environment was slower than the rate it adopted it (Smith *et al.* 2001:131). Cowles (1959:292), for instance, suggested over four decades ago that 'it seems reasonable to presume that pigmentation, like numerous morphological traits of man, has persisted long after its utility had been reduced by changes in his way of life'. Evolutionary biologists argue that the adaptive lag is relatively small (e.g. Laland and Brown 2006) while evolutionary psychologists claim it is atypically large (e.g. Cosmides and Tooby 1987), yet all agree that a response to a new habitat cannot be instantaneous. Thus, it is most likely that individuals or groups of the 'nomadus' tried to relocate to different habitats or adopt a sedentary lifestyle throughout their history. These individuals or groups must have faced difficulties in the new

habitat, which resulted in decreased survival rates and ability to propagate their genes. In sum, if '*Homo sapiens nomadus*' would adopt a sedentary lifestyle or vice versa, it would necessitate behavioral, cultural and ideological modifications and adaptations as well as adjustments in morphology and physiology. This was particularly complicated in antiquity when survival was uncertain. Habitat altering stood in contrast with sustaining a long-term survival and was not a natural choice.

This notion finds support among anthropological studies as well. Lipton (1982:266) states that humans discover a set of solutions to ensure survival, namely a survival algorithm. 'That is, he has found a group of decisions about allocating farm resources, which allows him just tolerable levels of profit, security and status. This survival algorithm allows him to muddle through in good years and bad alike. Naturally, he is reluctant to change it'. According to Wharton (1971:171) 'The peasant, through his inherited institutions and his traditionally determined socio-economic behavior, has developed a strategy to win the basic struggle for survival. He will not relinquish this strategy easily.' Paraphrasing these observations to a behavioral ecology context, we could say that humans, like other organisms, are averse to relinquishing a familiar and well-fitted habitat. This notion also finds support in historical accounts. Ibn Khaldun, an Arab historiographer and historian, who is said to have been the first social scientist, discusses the relationship between nomads and urban populations in his notable book *Al Muqaddimah* (the introduction to history) written in the 14th century AD. Ibn Khaldun notes that nomads, 'inhabitants of the desert' as he defines them, had a healthier temper (than that of sedentary people), good digestion and were more remote from illness (Ibn Khaldun 1967:377). Ibn Khaldun's stresses that 'Berbers [nomads] were firmly rooted in desert life' and 'they had no interest in buildings, let alone towns' (ibid:267). According to Sharon (1970), the Islamic conquests in the Middle East, beginning in the 7th century CE, made agricultural regions available for Bedouin tribes to settle in. However, the Bedouin tribes had refrained from settling down and chose to maintain their nomadic lifestyle. Sharon notes that the persistence in maintaining a nomadic lifeway is a well-known phenomenon among Bedouins in other regions of the Islamic conquest as well. Arif el Arif who served as the governor of Beer-Sheba under the British government of Palestine, sought to track down the origin of the Negev Bedouins. According to el Arif, the Bedouins immigrated to the Negev from the Hejaz and Sinai. They chose to occupy the arid zones of the Southern Levant and maintain similar economic occupations as they had in their homelands (El-Arif 1944). Apparently, Bedouins and other nomadic groups chose not to settle down even when historical episodes allowed it. They achieved a survival algorithm, which they were reluctant to relinquish. Individuals or groups may have tried to settle down but likely suffered from the adaptive lag. Studies of contemporary hunter-gatherer groups show that even at the beginning of the third millennium, these groups refrain from

settling down. They maintain their original habitat and original lifestyle, which they are familiar with, and well adapted to (Fortier 2000, 2003; Marlowe 2005).

A recent genetic study also supports the views presented here. The study has compared the distribution of rainfall with the distribution of Y-chromosome haplogroups. The analysis identified two offsetting sister clades. The results show that haplogroup J2a coincides closely with regions characterized by ≥ 400 mm of annual precipitation capable of supporting settled agriculture, while haplogroup J1-M267 distributions correlate inversely with semi-arid regions characteristically used by pastoralists (Chiaroni *et al.* 2008). We may assume that if the Southern Levantine population repeatedly changed its lifestyle from sedentism to nomadism and vice versa, we would not find a pronounced spatial distribution of two haplogroups.

In conclusion, in order to gain a better perspective on human behavior and decision-making, we may consider humans as any other organism in its natural ecosystem. The foundations of the model proposed here are that the primary goal of humans, as well as other organisms, is to secure their existence and perpetuate their genes. Diversification enabled a larger number of individuals to sustain themselves and secure the perpetuation of genes. I suggest that two sister-species '*Homo sapiens nomadus*' and '*Homo sapiens sedentus*' evolved to enable the exploitation of diverse ecological niches and as a result sustained a larger number of individuals of both species. Both species were invested in their ecological niche. They maintained niche construction through modifying components of their surroundings and they carried out active interactions with their environment. They regulated their population-size to hedge against depletion of environmental resources. They modified their sociological, cultural and ideological behavior as part of the adaptation process. Spooner (1971:204) underlined the ideological behavior saying that 'as part of their adaptations they have developed a group of ideology which claims, often aggressively, that their particular environment, and the technology they used to exploit it, produced the best life' (see also Chang 1993:700; Redman and Kinzig 2003:11). In addition, both species went through morphological and physiological adaptations, which increased their fitness. Increased fitness enabled a larger number of individuals to sustain themselves in each niche. This in fact was a primary motivation for the 'nomadus' and 'sedentus' not to relinquish their habitats. Relocating to a different habitat would have forced them to undergo new processes of niche construction and regulation of the population-size. Furthermore, habitat relocation would have involved sociological, cultural and ideological readjustments and modifications of physiological traits. Medical studies support the adaptive lag notion, showing that habitat altering for humans is accompanied by health problems and various complications. Both pastoral-nomads and sedentary populations adopted a survival subsistence strategy, which provided optimal adaptedness to their respective habitat. In other words, shifting habitats would weaken their survival algorithm rather than enhance it. Thus, the notions presented here do

not support views arguing that pastoral-nomads and sedentary populations in the ancient Near East repetitively altered their habitat and lifestyle.

If the notion of sedentarization and nomadization cycles is rejected, an alternative interpretation of the oscillation of settlement patterns in the Bronze and Iron Age should be considered. The history of the ancient Near East is rich with instances of redistribution and forced movement of autochthonic populations (Sherratt and Sherratt 1993; Porter 2004). Historical records show that regional superpowers such as Egypt (Levy and Holl 2002), Assyria (Broshi and Finkelstein 1992; Master 2003; Finkelstein and Silberman 2006:125; Younger 2002:291) and Babylon (Wolff 2002) carried out successive deportations and resettlements of Southern Levantine populations during the Bronze and Iron Age. Therefore, if we accept the notion that 'homo sapiens nomadus' and 'homo sapiens sedentus' were reluctant to repeatedly alter their habitat and lifestyle, the oscillation of settlement patterns should be attributed to political forces.

Economic Strategies of Sedentists

Traditional agriculturalists prefer costly 'security' strategies to strategies which might maximize their long-term earnings but which include unacceptable risks to survival (Johnson 1972:151).

Two schools of thought are outlined above, one advocating a market economy and the other argues that the survival subsistence strategy prevailed in the Bronze and Iron Age. In order to assess the economic strategies practiced in the Southern Levantine Bronze and Iron Age, a quantitative analysis of zooarchaeological and ethnographic data from 70 sites and strata was carried out. If a market economy was prevalent, we ought to find evidence in the zooarchaeological record for specialized economy and trade in livestock and their products. If the survival subsistence strategy was prevalent, the zooarchaeological evidence should point to a conservative and self-sufficient economy that strived for preservation of the subsistence resources and for minimizing risks.

Several economic models describe livestock production and consumption and the way it is reflected in the zooarchaeological record. Wapnish and Hesse (1988:83–5) suggested three strategies of animal production and consumption:

1. self-sufficient production and consumption—animals are reared and exploited locally, with the intention of producing meat, milk, and wool. In this case, livestock with a wide range of ages will be found at the site;
2. consuming economy—animals are acquired from pastoral specialists in addition to those raised locally. This model is attributed to rural and pastoral-nomadic societies who export parts of their products to the urban markets. In this case, the relative frequency of 'market-age animals' (18-30 months) at the site is expected to be low;

3. producing economy—animals are raised locally for community consumption as well as for export. In this case the relative frequency of ‘market-age animals’ at the site is expected to be high.

Zeder (1991:33-44) suggested a model of direct and indirect consumption. In sites that maintain a self-sufficient economy and livestock products are produced and consumed at the site, a relatively wide range of animal species, ages and skeletal elements is expected. In sites that, for the most part, are provisioned indirectly with animal products (e.g., through markets), a small range of species, ages and skeletal elements is expected (Zeder 1984, 1988; see also Crabtree 1990:164; LaBianca 1995a:61; Stokes 2000:151). Crabtree (1996) demonstrates Zeder’s model on a site from eastern England. The faunal remains from Ipswich, an urban center dated to the 7th–9th century CE, reveal a limited range of age profiles and higher than expected proportion of swine and cattle. According to Crabtree this was because the site received its meat supply from neighboring rural sites indirectly. Landon (1997:55–6) who examined the zooarchaeological finds from colonial Massachusetts advocates a similar model of indirect provision: ‘Urban control over production or the development of specialized production to provide meat to urban markets will tend to increase the proportion of relatively young animals in the urban assemblages’. Thus a zooarchaeological analysis should provide us with substantial evidence on the economic strategies practiced in antiquity. My hypothesis, as presented above, is that the zooarchaeological record from the Southern Levant would point to a self-sufficient economy and direct production and consumption of animal products. Moreover, the zooarchaeological evidence should show an economic strategy that strived to minimize risks and sustain a long-term survival.

Methods and Database

Archaeologists must occasionally discard the tint of the archaeology is prehistoric ethnology mantra and consider the archaeological record as potentially revealing something invisible to an ethnologist. It may reveal nothing, but how will we know unless we look? (Lyman 2007:145)

Economic strategies in the Bronze and Iron Age, as reflected in the faunal remains, were studied using three common measures than can be found in the majority of the zooarchaeological reports:

1. **Sheep/goat ratio:** caprines (sheep and goat) are the predominant species in all zooarchaeological and ethnographic records studied here. The ratio between sheep and goats was calculated from 57 zooarchaeological and ethnographic datasets. The sheep/goat ratio reflects economic and ecological decisions that will be discussed below.
2. **Strategies for caprine exploitation:** mortality profiles of caprines can reflect their utilization for meat, milk, wool or all the above.

Comparative analysis of mortality profiles in various settlement types and geographical regions can indicate patterns in herd-management strategies and economic decisions.

3. **Caprine/cattle ratio:** caprines and cattle are the most common livestock species in the Southern Levant. The ratio between these species should be an excellent measure for testing the hypothesis of the survival subsistence strategy. Furthermore, this study revisits theories on the relationship between cattle proportion and the intensity of agriculture and between cattle proportion and meat production in antiquity.

The database was compiled from 50 zooarchaeological reports and ethnographic sources representing a total of 70 sites and strata to be studied (Table 2.1, Figure 2.1). The majority of sites date to the Bronze and Iron Age. Sites dating to the Persian, Roman and Islamic periods were also included in the quantitative analysis to broaden the spectrum of sites examined. The sites are spread in all the key geographical regions in Israel: the Galilee, the Northern Valleys, the Central Hill, the Coastal Plain, the Shephelah, the Northern Negev, and the Southern Negev (Figures 2.1 and 2.2). An extensive archaeological, zooarchaeological and ethnographic study was carried out in Tell Hesban, situated on the desert fringe in Jordan (LaBianca 1995c; Ray 2001). The environmental setting of the site is similar to the Northern Negev thus data from the major strata at the site were included in the analysis too. Ethnographic data on the relative abundance of sheep, goats and cattle was included in the quantitative analysis. It was retrieved from two sources:

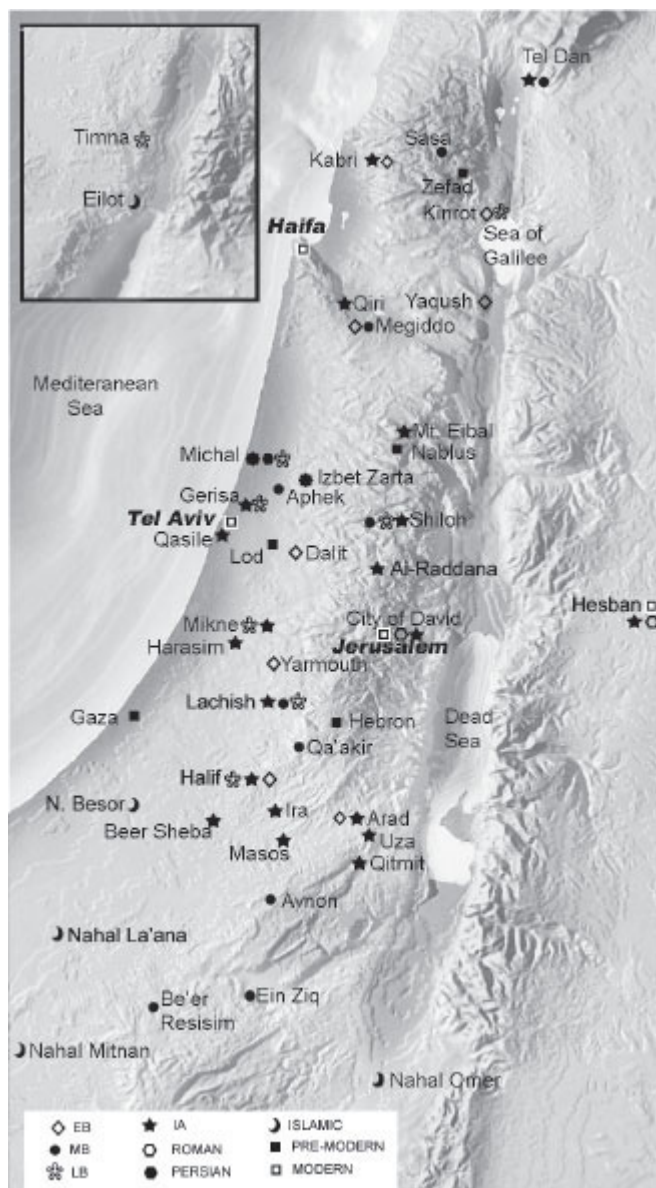


Figure 2.1 Map of sites mentioned in text (based on a map created by Digital Wisdom®).

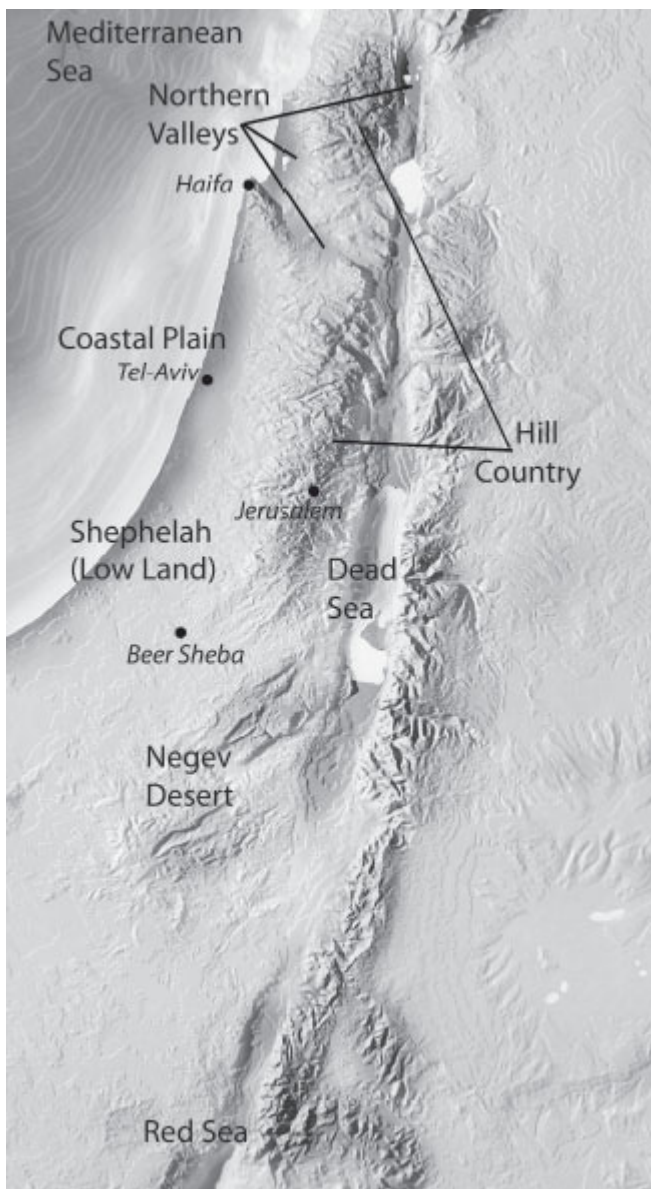


Figure 2.2 Primary geographic regions of the land of Israel.

- a. an animal census carried out in 1943 by the British Mandatory Government of Palestine (Government of Palestine 1943; see also Sasson 2006). Statistics regarding the frequency of sheep in four districts, representing three primary geographical regions were combined in the quantitative analysis; Sefad District, representing the Galilee region, Hebron District, representing the Central Hill region and the districts of Gaza and Lod, representing the Coastal Plain and Shephelah regions. The definition 'district' was added to these sites in order to distinguish them

from the archaeological site (e.g. Hebron (district);

- b. an animal census carried out by LaBianca's team at the village of Hesban in Jordan in 1970 (LaBianca 1995b). The data from this census is referred to as 'Hesban 1970', in the database.

An effort was made to include various types of settlements. The majority of sites included in the database represent the two most common types of settlements, urban and rural. In addition, the database includes cult sites, burial sites and sites characterized as fortresses.

The sheep/goat ratio and the cattle/caprine ratio was retrieved from data on the number of identified specimens (NISP) for each species. The ratio was calculated in percentages. For instance, if the bone assemblage at a site was comprised of 60 identified sheep bones and 40 goat bones, the total NISP value would be 100 and the relative frequency of sheep at the site would be 60%. The same method was carried out for calculating the caprine/cattle ratio. It is important to note that caprines and cattle normally represent over 90% of the bone assemblages in most sites. Other species are normally negligible to the total NISP. However, in several sites the NISP for other species was relatively high. For instance, in Tel Dan, deer comprised 16% of the entire assemblage (Wapnish and Hesse 1991) and in Tel Miqne, pig comprised 17% of the assemblage (Lev-Tov 2000). Nonetheless, since the focus of this work is the caprine/cattle ratio, other species were excluded from the calculation. In other words, 15% cattle represents 15% of the total NISP of caprines and cattle.

There is an ongoing debate about the use of minimum number of individuals (MNI) and number of identified specimens (NISP) as measures of the relative frequency of taxa (cf. Grayson 1984; Klein and Cruz-Uribe 1984; Ringrose 1993; Lyman 1994a; Reitz and Wing 1999). For this work, NISP was chosen as a comparative measure for two primary reasons: first, the NISP is the most common count and can be retrieved accurately from the raw data in zooarchaeological reports. MNI values, on the other hand, are not available in all reports and are difficult to obtain from raw data. Second, in small bone assemblages, the probability for bias in the MNI count is higher. Amorosi *et al.* (1996:138) refer to this issue: 'In practice, we normally make use of the basic NISP count for most comparisons, as it is the least mathematically transformed, the least idiosyncratic (there are at least a dozen different ways of calculating MNI) and the most suitable statistically for manipulating small collections' (see also Tchernov and Horwitz 1990:209). Redding (1993:84) argues that the validity of the NISP count to provide measures of relative abundance will only become apparent when a pattern appears. In other words, when two sets of data on relative abundance of taxa exhibit similar patterns within and among sites, this provides strong evidence of the reality of the pattern and that 'patterns in the data are more likely to be explained by spatial and temporal variation in subsistence strategies and tactics used by the inhabitants of the site'. The database presented here affirms Redding's argument; patterns of the

relative frequency of caprines and cattle clearly appear when using the NISP count within and among sites, providing strong validation to the NISP method.

Sheep/goat ratio

Models of Sheep/Goat ratio. Caprines (sheep and goats) have dominated livestock herds in most sites in the Levant from the time they were domesticated to premodern times (Levy 1983:19; Buitenhuis 1990:198–99; Sasson 1998; O'Connor 2000:151; Hesse and Wapnish 2002). Maintaining mixed herds rather than focusing on a single species is a rational strategy, particularly in conditions of uncertainty. The strategy of mixed herds was discussed above. Therefore, I shall briefly list the advantages of rearing sheep and goats in mixed herds:

1. Both species are relatively resistant to arid conditions (Evenari *et al.* 1971:178; Degen 2007);
2. Sheep and goats are able to exploit different portions of the same pasture area. Sheep are selective grazers exploiting areas where grass regenerates at regular intervals while goats survive on thorny bushes and acacias, but they also eat grass. As a result, herders of mixed herds achieve efficient utilization of their limited grazing resources (Tchernov and Horwitz 1990:207–8; Cribb 1991:28);
3. Mixed herds reduce the risk of wholesale loss through disease (Halstead 1996:24; Smith 1978:85);
4. Reproduction rates for both species are relatively high, which ensures stable production of caprine products (e.g. meat, milk, wool, hair) and quick recuperation of herds after periods of stress (Dahl and Hjort 1976:103; Russell 1988:73–4).

It is apparent that the underlying principles behind rearing mixed herds such as resistance to aridity and epidemics, efficient utilization of resources, high reproduction and quick recuperation can be all attributed to a strategy of risk minimization and long-term planning—namely a survival subsistence strategy.

The question arising is whether one should expect a particular ratio between these two species and what the implications of such a ratio would be. Redding (1984) addressed this issue and suggested possible goals for sheep/goat herding: maximizing energy (calories) or protein intake (through their products; i.e. meat and milk), or herd security. He argued that if the goal of subsistence herding was energy (or protein), and since reproduction rates of goats are higher than that of sheep, the expected ratio between sheep and goats would be 5:1 (i.e. 83% sheep in a mixed herd). On the other hand, if the main goal is security and minimizing fluctuations in herd size, the sheep/goat ratio should be as close as possible to 1:1. However, because of the aforementioned

difference in reproduction rates, the expected ratio is between 1:1 and 1:1.7 (50 to 63% sheep in a mixed herd). Redding (1984:239) concludes 'the goal of subsistence herding in the Middle East was probably not energy or protein, but herd security'.

Before testing Redding's theory, I shall discuss the unique attributes for each species. The first feature that should be noted is the goat's foraging habits compared to those of sheep:

Sheep are selective grazers that need areas where grass regenerates at regular intervals. Goats survive on thorny bushes and acacias, but they also eat grass. Goats do not like moist conditions, but are well adapted to both cold and hot climates; they can also travel longer distances than sheep each day, these factors make them more suitable as desert animals than sheep (Dahl and Hjort 1976:251).

Besides their higher reproduction rate, goats are remarkably adaptive to harsh climates. Their thermoregulation and panting rate (respiratory cooling) is only about half of that of sheep. Furthermore, their sweating is limited, and their water loss through feces and urine is low as well. Goats can function even after losing 30% of their body weight, while a 15% weight loss is considered lethal for most other mammals. Goats are able to recover quickly after periods of water shortage and are able to drink water equivalent to 20–40% of their body mass in one visit to a water source, which is initially retained in the rumen (Clutton-Brock 1987:57; Shkolnik 1988:487–96; Swift 1973:73; Jessen *et al.* 1998; Cain *et al.* 2006:570–2). According to Finch *et al.* (1980), a goat's dark coat allows it to cope successfully with cold weather and reduction in metabolic rates. Choshniak *et al.* (1995:1104) carried out experiments on Bedouin goats and showed that:

When provided with less than one-half of the food that they would normally eat, Bedouin goats switched down metabolism to a level at which they could maintain energy balance. The reduction was both immediate and dramatic. The low metabolism enabled the goats to maintain a nearly constant body weight despite their limited food supplies.

What made sheep favorable in the ancient world was evidently their wool. Sheep's meat and milk is richer in fat and proteins compared to goats (Sasson 2006: Table 1). Had wool not been a prime raw material for fibers, the relative number of sheep per household unit would have been smaller (Sasson 2008). McCorriston (1997:518) asserted that flax plants were domesticated earlier than sheep and that linen was the primary textile fiber at that time; wool replaced linen as the main textile fiber after the domestication of sheep. She also noted that producing fiber from wool was more efficient than linen fiber production. Cultivating and processing of flax for fiber requires prime agricultural land, frequent watering, and high labor inputs. Fewer herders could tend more sheep for a greater fiber volume than could be generated by the same people growing flax (*ibid*:522–5). Sassoon (1987:140) who studied the economy of Iraq in the first half of the 20th century provides us with similar observation regarding contemporary Iraqi peasants. According to Ryder (1993:10), after sheep were

domesticated they outweighed goats in caprine herds, by virtue of their wool. Many scholars have highlighted the value of sheep for textile manufacturing. King and Stager state that wool was a major class fiber in the ancient Near East and that sheep were raised primarily for their wool (King and Stager 2001:113, 147, see also Hopkins 1993:207; Horwitz and Milevski 2001:300; Shamir 2002:21). The significance of sheep for wool production in Mesopotamia was noted by Van De Mierop (1993:165), Adams (1981:149–50), Sherratt (1981:282–3) and Stepien (1996:40–8). Killen (1993) noted this in regard to Late Bronze Age Mycenaean texts. Ochsenschlager (2004:203) who carried out an ethnographic study in Southern Iraq asserted: ‘The primary reason for keeping sheep is their wool, only a few shepherds milk their sheep’. Sherratt suggested that wool was introduced to North-Central Europe in the mid-3rd millennium BCE and was used in conjunction with linen until it became the dominant textile fiber during the 2nd millennium BCE (Sherratt 1983:93, see also Ryder 1984:79–81; Davis 1987a:186).

In conclusion, although goats did not produce wool, they were favored for their survival adaptations while sheep were favored for their wool despite their relative vulnerability to environmental stress. Breeding both species in mixed herds attained both goals in addition to others that were mentioned above. This leads us back to the question: what can we infer about economic strategies in the Bronze and Iron Age from the ratio between sheep and goats?

Sheep/goat ratio: Results. As mentioned above, not all zooarchaeological reports provide data on the sheep/goat ratio. The study is thus based on data from 57 sites and strata (Figure 2.1). In 76% of the sites and strata that were reviewed, the relative frequency of sheep bones (out of the total of identified sheep and goats bones) did not exceed 67% (Table 2.1). This pattern corresponds with Redding’s model (Redding 1984), indicating that caprine herd management was a planned strategy, which focused on herd security and risk minimization. By modifying Redding’s model we may establish the following equation: if energy and wool production were the main goals of early herders, one would expect to find 100% sheep; however, if security was the goal, the herd would consist of 100% goats. The rationale behind a mixed herd of approximately two-thirds sheep and one-third goats was gaining satisfactory wool production on the one hand and maintaining herd security on the other hand.

Tchernov and Horwitz (1990:212) studied land capacity and herd management based on data from five archeological sites in Israel. They argued that a regional pattern in sheep/goat ratio can be detected and that the frequency of goat bones increases moving from northern regions in Israel (moister) to the southern (drier) regions (see also Horwitz and Tchernov 1989). Their argument should be reevaluated, especially in light of the fact that it was established on a considerably small sample of only five sites. In this study, sheep frequency from 57 sites and strata was tested statistically against three

variants: settlement type (urban or rural); geographical location; and the combination of both factors. The hypothesis to be tested is: could we observe a higher proportion of sheep in urban sites governed by ruling classes (Hopkins 1996:128; Herzog 1997:13; LaBianca 1999:21), in view of the political power wielded through control over natural resources such as water and pasturelands? A regional pattern in the relative frequency of sheep, as advocated by Horwitz and Tchernov was tested as well. The statistical test (two-way ANOVA) was carried out on $\arcsin \sqrt{p}$, where p stands for the sheep proportion at the site (in order to reach a normal division). For this test, I joined the site of Tell Hesban (Jordan) together with the Northern Negev sites. In addition, the low land regions—the Shephelah, the Coastal Plain and the Northern Valleys sites—were treated as one geographical region (Figures 2.1 and 2.2). The statistical test showed no significant difference between sheep proportion and settlement type ($p = 0.825$) nor between sheep proportion and geographical region ($p = 0.925$). Likewise, no interaction was found between sheep proportion, settlement type, and geographical location ($p = 0.148$). This clearly indicated that site location (i.e. northern or southern region) did not influence the sheep proportion and that a regional pattern related to sheep/goat ratio cannot be traced. Likewise, no pattern regarding the type of settlement is evident; a significant number of sites comprising mixed caprine herds, of which approximately two-thirds were sheep, is observed in many sites, rural as well as urban. This refutes the hypothesis that the proportion of sheep in urban sites would be higher because they were inhabited by elites.

<i>Site and Strata</i>	<i>Period</i>	<i>Region</i>	<i>Type of Settlement</i>	<i>Sheep in % (out of total caprines)</i>	<i>Mortality profile and caprine products</i>	<i>Reference</i>
Eilat Zarta	IA	Coastal Plain	Rural	100	s	Heilwig 1986
Shiloh	LD	Central Hill	Rural	92	Young	Heilwig 1993
Dalir	EB II	Shephelah	Urban	87	All	Horwitz, et al. 1996
Uza	IA II	Northern Negev	Fortress	82	All	Sade 1988
Shiloh	IA I	Central Hill	Rural	77	All	Heilwig 1993
Shiloh	MB II-III	Central Hill	Urban	77	Young	Heilwig 1993
Yamvouth	EB	Central Hill	Urban	75	All	Davis 1988
Arad XII-VI	IA II	Northern Negev	Fortress	75	All	Sade 1988
Yaqush	EB III	Northern Valleys	Rural	74	All	Hesse-Wapnish 2001
Megiddo	EB I	Northern Valleys	Urban	73	All	Wapnish-Hesse 2000
Beer Sheva IX-VI	IA I	Northern Negev	Rural	72	All	Heilwig 1984
Yaqush	EB II	Northern Valleys	Rural	72	All	Hesse-Wapnish 2001
Qitmit	IA II	Northern Negev	Cultic	72	Young	Horwitz-Raphael 1995
Yaqush	EB I	Northern Valleys	Rural	71	All	Hesse-Wapnish 2001
Megiddo	EB III	Northern Valleys	Urban	67	Young	Wapnish-Hesse 2000
Qasile	IA I	Coastal Plain	Rural	67	All	Davis 1988
Halif	IA II	Northern Negev	Urban	66	All	Zeder 1990
Miqne	IA II	Shephelah	Urban	65	All	Lev-Tov 2000
Masos	IA I	Northern Negev	Rural	65	All	Tchernov-Drori 1983
Halif	EB III	Northern Negev	Urban	63	Young	Zeder 1990
Hesban XV-XVII	IA II	Jordan	Rural	62	All	LaSancea 1990 + 1995a

Sasa (Tomb)	MB II	Galilee	Burial	60	All	Horwitz 1987
City of David	Roman	Central Hill	Urban	60	All	Horwitz 1996b
Ira	IA II	Northern Negev	Urban	60	All	Dayan + Horwitz 1995b
Arad	EB	Northern Negev	Urban	59	All	Davis 1976+Lernau 1978
Hesban XI-XIV	Roman	Jordan	Rural	58	x	LaBianca 1990+1995a
Lod (District)	1943	Coastal Plain	Rural	58	x	Gov. of Palestine 1943
Qa'qir (Tomb)	MB I	Central Hill	Burial	58	Young	Horwitz 1987
Dan (Tel)	EB II-III	Northern Valleys	Urban	57	All	Wapnish-Hesse 1991
Hesban XVIII-XXI	IA I	Jordan	Rural	57	All	LaBianca 1990+1995a
Beer-Sheva II	IA II	Northern Negev	Urban	56	All	Sasson 2004
Dan (Tel)	IA II	Northern Valleys	Rural	56	All	Wapnish-Hesse 1991
Miqne	IA I	Shephelah	Urban	56	All	Lev-Tov 2000
City of David	IA II	Central Hill	Urban	55	All	Horwitz 1996b
Avnon	MB I	Southern Negev	Rural	50	All	Hakker-Orion 1999
Be'er Resisim	MB I	Southern Negev	Rural	50	All	Hakker-Orion 1999
Halif	LB	Northern Negev	Urban	50	Young	Zeder 1990
At - Raddana	IA I	Central Hill	Rural	50	All	Hesse 1999
Ein Ziq	MB I	Southern Negev	Rural	50	All	Hakker-Orion 1999
Qiri	IA II	Northern Valleys	Rural	50	All	Davis 1987b
Lachish VI	LB	Shephelah	Urban	48	x	Droni 1979
Harasim IVb	IA II	Shephelah	Urban	47	All	Maher 1999
Hesban II-III	Mamluk	Jordan	Rural	47	x	LaBianca 1990+1995a
Miqne	LB	Shephelah	Urban	47	All	Lev-Tov 2000
M. Ebal	IA I	Central Hill	Cultic	44	x	Horwitz 1986/7
Timna	LB	Southern Negev	Cultic	44	Young	Lernau 1988
Hebron (District)	1943	Central Hill	Rural	39	x	Gov. of Palestine 1943
Gaza (District)	1943	Coastal Plain	Rural	39	x	Gov. of Palestine 1943
Zefad (District)	1943	Galilee	Rural	39	x	Gov. of Palestine 1943
Lachish VIII	ME	Shephelah	Urban	38	x	Droni 1979
Kabri	EB	Coastal Plain	Urban?	32	All	Horwitz 2002
Lachish III-IV	IA II	Shephelah	Urban	26	x	Droni 1979
City of David	IA I	Central Hill	Rural	25	All	Horwitz 1996b
Hesban	1970	Jordan	Rural	22	x	LaBianca 1995b
Eilat	Islamic	Southern Negev	Rural	0	All	Horwitz 1993
Nahal La'anah	Islamic	Southern Negev	Rural	less	x	Nachlieli 1999
Nahal Omer	Islamic	Southern Negev	Rural	less	x	Nachlieli 1999
Gerisa	IA I	Coastal Plain	Rural	x	All	Sade 2001

Gerisa	LB III	Coastal Plain	Urban	x	All	Sade 2001
Michal	IA	Coastal Plain	Rural	x	All	Helwing-Feig 1989
Michal	Persian	Coastal Plain	Rural	x	All	Helwing-Feig 1989
Michal	LB	Coastal Plain	Rural	x	All	Helwing-Feig 1989
Aphik	MB II	Coastal Plain	Urban	x	All	Helwing-Feig 1989
Harasin IVd	IA II	Shephelah	Urban	x	All	Maher 1998
Kinrot	EB	Northern Valleys	Urban?	x	All	Helwing 1988/9
Kinrot	LB	Northern Valleys	Urban?	x	All	Helwing 1988/9
Kabri	IA II	Coastal Plain	Fortress	x	All	Horwitz 2002
Dau (Tomb)	MB	Northern Valleys	Rural	x	All	Horwitz 1996a
Nahal Desor	Islamic	Northern Negev	Rural	x	x	Nachlieli 1999
Nahal Mitnan	Islamic	Southern Negev	Rural	x	x	Horwitz 1995

Table 2.1 Caprine exploitation and the relative frequency of sheep in studied sites. X = no available data; All = caprines were exploited for all their products; Young = high frequency of young caprines.

During the Mandate period in Palestine, the British Mandatory government carried out several censuses in order to evaluate the demographic and economic potential of the region (Brawer 1990; Finkelstein 1992a; Sasson 1998, 2006). I have compiled the data from the enumeration of livestock carried out in 1943 (Government of Palestine 1943). The study reveals noteworthy statistics (Table 2.2): sheep comprised only 39% of the 700,000 caprine heads counted in Mandatory Palestine. Hirsch (1933:7) reported similar statistics from an animal census carried out in 1930, where sheep comprised 36% of all caprines. A comparison between the zooarchaeological data presented above and the data from the British census shows a dramatic shift in the proportion of sheep from approximately two-thirds in the Bronze and Iron Age to one-third in pre-modern times. Furthermore, a regional pattern in the sheep/goat ratio can be detected: in the mountainous districts (Galilee, Samaria, and Jerusalem; see Figure 2.2) the frequency of sheep is significantly smaller (33–40%) compared to the Coastal Plain region (Lod district, 58%). These data can be interpreted based on the model of the survival subsistence strategy. The cause of the dramatic drop-off in the proportion of sheep between ancient periods to premodern times was that wool was no longer essential for textile production. Following the industrial revolution, cotton and other modern substitutes grew to be the principal raw materials of the textile industry (Donnell 1872:7; Chapman 1972:17–27; Jacobson and Smith 2001:41–4). Considering the survival subsistence strategy was still maintained in premodern times, the proportion of goats increased in order to maximize herd security. Nevertheless, a higher proportion of sheep was observed in the lowlands. The reason for this is that the carrying capacity (i.e. pasturage) is higher for sheep in the lowlands than in the highlands (Seligman *et al.* 1959: Table 8; see also Sasson 2005a). Hence, rearing sheep in higher proportions in the lowlands did not compromise herd security.

DISTRICT	Sheep	Goat	Total Caprines	Sheep in %
A. GALILEE DISTRICT	67,224	139,167	206,391	33
1. Akko Sub-District	6,595	59,465	66,060	10
2. Beisan Sub-District	16,327	13,003	29,330	56
3. Nazareth Sub-District	10,988	21,260	32,248	34
4. Safad Sub-District	20,462	31,644	52,106	39
5. Tiberias Sub-District	12,847	16,795	29,642	43
B. HAIFA DISTRICT	14,637	42,881	57,518	25
1. Haifa Sub-District	14,637	42,881	57,518	25
C. SAMARIA DISTRICT	55,607	87,985	143,592	39
1. Jenin Sub-District	17,011	37,404	54,415	31
2. Nablus Sub-District	24,356	40,319	64,675	38
3. Tulkarm Sub-District	14,240	10,262	24,502	58
D. JERUSALEM DISTRICT	96,992	142,794	239,786	40
2. Jerusalem Sub-District	22,852	29,740	52,592	43
3. Ramallah Sub-District	18,337	27,089	45,426	40
E. LYDDA DISTRICT	23,589	16,849	40,438	58
1. Jaffa Sub-District	3,924	2,863	6,787	58
2. Ramle Sub-District	19,665	13,986	33,651	58
F. GAZA DISTRICT	no data	no data	no data	no data
1. Beersheba Sub-District	no data	no data	no data	no data
2. Gaza Sub-District	27,430	7,964	35,394	77
Total	285,479	437,640	723,119	39

Table 2.2 Relative abundance of sheep and goats in mandatory Palestine (based on: Government of Palestine 1943).

To conclude, the sheep/goat data from the British census indicates that the survival subsistence strategy was fundamental in the life of pastoralists throughout time: from the days of caprine domestication to premodern times. This strategy is also observed through sheep/goat ratio in various types of settlements and geographical regions.

Strategies of Caprine Exploitation (For Meat, Milk or Wool)

Kill-off patterns and herd management. Many scholars have discussed kill-off patterns in caprine herds and how they reflect utilization of caprine products such as meat, milk, wool, hair and hides (cf. Hesse and Wapnish 1985:73–7; Davis 1987a:157–60; Zeder 1991:33–44; O'Connor 2003:155–60). Payne (1973), in his pioneering study, suggested three mortality profiles of caprines; each profile is associated with the production of either meat, milk, or wool. According to Payne, a high frequency of sub-adult caprine bones in a faunal assemblage points to the utilization of caprines for meat: 'If meat production is

the aim, most of the young males are killed when they reach the optimum point in weight-gain, only a few being kept for breeding' (ibid:281). Many others followed Payne's model. Hellwing and Gophna studied the animal bones from the Bronze Age sites, Tel Aphek, and Tel Dalit and noted: 'For sheep and goat population, however, more young animals were killed in the Early Bronze Age (5.8%) than in the Middle Bronze Age (3.4%). This may mean that in the earlier period small ruminants were raised mainly for their meat, whereas the secondary products of these animals—milk, wool, hides—were more important to the population in the later period.' (Hellwing and Gophna 1984:51). In an analysis of the faunal remains from Jilat in Jordan the authors assert: 'A study of caprine slaughter patterns at Jilat 13 found that the majority of animals were killed in the first few years of life, which might suggest that they were culled for meat rather than other products' (Garrard *et al.* 1996:218, for similar interpretations see Davis 1987a:157–60; Croft 2004:2268).

Before discussing the rationale behind the slaughter of sub-adult males, two comments should be made:

1. Slaughter of sub-adults is widespread among pastoralists. Perevolotsky (1986:291) describes this pattern in Peru; Brown (1971:96) in Africa; Thomson, Bahhady, Thermanini and Mokbel (1986:120) in Syria; Hesse (1984:250) in Iran; Cribb (1984:164) in Turkey; and Abu Rabia (1994:55) among the Bedouins of the Northern Negev.
2. Payne partly attributes the culling of sub-adults to their higher value in markets (Payne 1973:281–2).

Earlier, I pointed out that animal products in the Southern Levantine Bronze and Iron Age were aimed at household consumption and were not designated for 'export'. Namely, a household in these periods maintained, for the most part, a self-sufficient economy. If one accepts this premise, a different interpretation of the abundance of sub-adults in the zooarchaeological record should be considered. The logic behind culling sub-adults lies within the survival subsistence strategy that strived for minimizing fluctuations in the resource base. According to Redding, preserving the resource base (pasture and water in this case) is one of the strongest selective pressures operating on human behavior (Redding 1993:80). Horwitz and Smith (1990:655–64, see also Smith and Horwitz 1984) studied the effect of nutrition on sheep bone mass. They found a differential effect of poor environmental conditions on bone metabolism in ewes, and attributed it to the additional stress imposed on females by gestation and lactation. Therefore, in order to free pasturage and water for females that have a crucial role in reproduction and milk production, some components of the caprine herd should be culled (Dahl and Hjort 1976:32; Sherratt 1981:283–4). Hesse (1999:107) also refers to this mechanism: 'While it seems logical to let all animals die of natural causes to maximize production, some younger animals must be culled to provide a good fit to available pasturage and encourage herd growth' (see also Davis 1987a:157–60).

Dahl and Hjort (1976:88) noted that culling males improves the survival of the ewe lambs as well: 'In western Sudan, for example, insufficient grazing keeps lamb mortality in the nomadic flocks at a high level, and if male lambs are slaughtered, the survival chances for ewe lambs are improved'. The logic behind culling males over females is obvious: the contribution of males to herd reproduction and milk production is negligible (Sasson 1998).

Sub-adult age is ideal for culling since caprines (as well as cattle) reach 70% of their maximal body weight between the ages of one and three (Lernau 1978:83; Horwitz 1989a:19; Vigne 1991:31; Borowski 1998:57). Sherratt noted in regard to cattle, that the amount of fodder required for feeding seven calves at two years of age feeds merely 3.5 cattle heads at three years of age. However, cattle weight at the age of three is not doubled compared to the age of two (Sherratt 1981:283–4 see also Reid 1996; Landon 1997:55). Thus, males will be culled at an age where their pasture consumption curve starts exceeding their body weight curve. Moreover, once culled, their mothers' milk is directed to the consumption of the household rather than for the feeding of juvenile animals. Cribb (1984) conducted a computer simulation in order to examine various kill-off strategies (i.e. culling) in caprine herds. He showed that 'by increasing the immature killoff, a marked improvement in milk productivity is achieved. Furthermore the level of meat productivity follows milk upwards and wool productivity remains high' (Cribb 1984:168).

In sum, slaughtering sub-adult males is not necessarily related to 'meat export' or market forces. It is a coherent component in the survival subsistence strategy, which consists of optimal exploitation of caprines for meat and milk as well as the preservation of the resource base for females that generate milk and render continuity to the herd. This model also implies that the early pastoralists were long-term planners, stabilizing the sizes of their herds in order to preserve water resources and pasture. At first glance, this strategy has a pronounced weakness: Caprines and their products contributed significantly to the diet of all societies in the Southern Levant, nomadic, rural, and urban (Groen *et al.* 1964; Zeder 1984; Sasson 2006). The conflict between the drive to increase population size and the need to maintain it at a fixed size was discussed above (Liebig 1842). My conclusion is that in light of the survival subsistence strategy, pastoralist groups favored a stable population, a stable flock size, stable subsistence resources and minimum fluctuations, over expanding their population size or gaining wealth.

Two final methodological remarks regarding the age groups of young and adult animals are worth noting. It is important to recognize that finds of young sheep and goat bones might be a result of natural causes, apart from the preplanned culling as described above. Cribb who carried out an ethnographic study of caprine herds in southern Turkey, noted that 15% of the newborns died of natural causes in their first year (Cribb 1984:167; see also Russell 1988:63; Borowski 1998:68–70). Abu Rabia (1994:107–14) provides us with similar mortality rates regarding the Bedouin herds in the Negev. Thus our

interpretation of the mortality profile should take into account death by natural causes of the young animals. Surprisingly, although data of mortality rates of caprines is well known, it is seldom invoked in zooarchaeological reports (for an exceptional example see Zeder 1990:27).

Culling of animals at adulthood also points to a herd management mechanism rather than market forces. Culling adult ewes and rams occurs when they reach the end of their productive life (reproduction and milk production), around the age of 5-6 years (Dahl and Hjort 1976:95; Cribb 1991:29; Ginguld *et al.* 1997:578; Sasson 1998). This mechanism reduces the risk of disease by refreshing the herd constantly and rebuilding it in a timespan of approximately five years (Sasson 2006:36). Ingimundarson (1992:221), who conducted his study on sheep in Iceland, noted that in order to increase wool production from their ewes, farmers had to replace their sheep stock rapidly. Culling mature and sub-adult animals regulates the herd size and maintains it roughly at a fixed size (Sasson 1998:9–10). Moreover, Perevolotsky (1986:303–304) noted that regulating the herd size was aimed at freeing members of the household for other tasks such as cropping. Binford (1978:453), in his comprehensive study of the Nunamiut Eskimo concludes: ‘the Nunamiut behave rationally in their treatment of animal foods. This rationality is facilitated by a truly remarkable knowledge of animal anatomy. It is facilitated by a general outlook that is future oriented.’

In conclusion, the abundance of sub-adults in a zooarchaeological assemblage must not be attributed to meat production or market forces. It should be attributed to death by natural causes as well as strategic culling. Culling of sub-adults as well as mature animals is a coherent ecological mechanism in herd management that coincides with the survival subsistence strategy. The logic behind this mechanism was to refresh the herd and regulate its size in order to free pasturage and water for the females. Consequently, milk produced by females is diverted to the household consumption.

Caprine products: Results. A study of 54 mortality profiles from various sites was carried out in order to study the pattern in caprine exploitation for meat, milk, or wool. Following Payne’s models (Payne 1973) and others who followed it, it would be reasonable to assume that if specialized production and a market economy were prevalent in the Bronze and Iron Age, we would observe diverse mortality profiles. Namely, one would expect to find mortality profiles pointing to specialization in wool while others pointing to specialization in milk or meat production.

The data presented in [Table 2.1](#) under the column of *mortality profile and caprine products* is based on the interpretation of zooarchaeologists that analyzed the faunal remains. In [Table 2.1](#), sites in which it was determined that caprines were exploited for all their products (i.e. meat, milk, and wool) are marked as ‘All’, while sites in which high frequency of young caprines was noted, were marked as ‘young’. The data show that in 45 of 54 sites (83%)

caprines were utilized for a whole range of products rather than a specific product (e.g. meat). This pattern may be observed in all periods of the Bronze and Iron Age and across all geographical regions in Israel, from the Northern Valleys through the Central Hill and to the Northern Negev (Figure 2.2). In all sites, mortality profiles point to the culling of sub-adults as demonstrated above. This evidently indicates that a specialized economy in meat, milk, or wool production was not prevalent in the Southern Levant. In other words, had a specialized economy of caprine products been practiced, one would expect to find diverse patterns that point to various specializations, in meat, milk, or wool production.

Following models of the Bronze and Iron Age economy proposed by Wapnish and Hesse (1988), Zeder (1991) and others, one would expect to observe a high proportion of 'market-age animals' (sub-adults) in urban sites (consuming economy) and a relatively low proportion of this age group in rural sites (producing economy). No evidence supporting these models was found in the rural or urban sites examined here. The data clearly indicates that a specialized economy was not prevalent in the Bronze and Iron Age. On the contrary, the data exhibited here points out a self-sufficient economy that was widespread in all periods, geographical regions and in both rural and urban sites. Regarding the debate between a market economy and the survival subsistence strategy, patterns of utilizing caprines for all their products strongly refutes the first notion and supports the latter.

Caprine/Cattle Ratio

What initially triggered the reassessment of economic strategies in the Bronze and Iron Age was the caprine/cattle ration in Tel Beer-Sheba (see Chapter 3). The bone assemblage from Stratum II comprised approximately 15% cattle (see Table 2.4). At first glance, this data is not surprising. A frequency of 15% cattle is common in many Bronze and Iron Age sites (Sasson 2005a) as well in at pre-modern villages in Israel (Sasson 1998; 2006). However, since Beer-Sheba is located on the 200 mm isohyet, cattle husbandry in this region would be a complicated and precarious investment. Cattle need to be watered frequently (Dahl and Hjort 1976:239–43) and they require approximately 50 liters of water per head per day (Ayoub and Alward 1996:134: Table 3). Consequently, their grazing area is limited to a radius of 8–16 km (Dahl and Hjort 1976:239; Russell 1988:57–9; Western and Finch 1986:81). In dry, hot seasons, cattle require even larger amounts of water and the herding distance grows shorter. Cattle also require a large amount of pasture, equivalent to 135 kg barley per month for a cow weighing 450 kg (Seligman *et al.* 1959:26–7, see also Clutton-Brock 1987:68; Rosen 1994:347; Halstead 1995:12; Stol 1995:195; Gutman *et al.* 2000). Compared to cattle, the water intake of caprines is significantly lower, approximately 2–3 liters a day (Evenari *et al.* 1971:148, for slightly different figures see Ayoub and Alward 1996:134 and Table 3; Zeder 1996:301). The

grazing area for sheep and goats is 15-30 km from a water source, twice the distance that cattle can be herded (Russell 1988:59; Evenari *et al.* 1971:311). Evenari *et al.* (1971:311) also note: 'unlike cattle, which are forced to stand still while grazing, the sheep moves as it grazes'. Dahl (1979) points out additional advantages of caprines over cattle asserting that an economy based on small stock has a greater flexibility and temporarily available investment opportunities, and alternatives can be more readily exploited by these pastoralists. In addition, when caprines are slaughtered, their meat can be consumed by a single family, whereas there are problems of storage and transport for the large amounts of meat from slaughtered cattle.



Figure 2.3 Tel Beer-Sheba location

<i>Year / Decade</i>	<i>Caprines</i>	<i>Camel</i>	<i>Mule</i>	<i>Cattle</i>	<i>Reference</i>
1930s	80,000	15,000		-	El-Aref 1944
1954	7,000	1,300	2300	-	Ashkenazi 1957
Early 1960s	70,000	10,000		-	Marx 1967
1970s	+	+		-	Ben David 1982
Middle 1980s	+	+		-	Abu Rabia 1994

In light of the above, 15% cattle bones in Northern Negev sites is striking. A review of ethnographic sources on Bedouins in the Negev desert in the 20th century supports this observation. It appears that the three most common livestock species bred by the Bedouin were sheep, goats and camels (Ashkenazi 1938:149; Marx 1967:20; Ben David 1982:122–4; Abu Rabia 1994:107–10 and see Table 2.3). Aref el Aref, the governor of the Beer-Sheba district in the 1930s, noted for instance that Bedouin tribes possessed 80,000 heads of caprines and 15,000 camels (El-Aref 1944:190). Conversely, cattle are not mentioned in his notes (Table 2.3). Cattle are not reported among the Bedouins of Transjordan as well (Blench 1998:4).

What is then the reason for the relative abundance of cattle bones found in the Negev Bronze and Iron Age sites versus their absence among Bedouins in premodern times? Before addressing this question, I shall discuss four methodological issues regarding cattle:

1. The relative frequency of cattle in the zooarchaeological record;
2. The relationship between cattle abundance and intensity of agriculture;
3. The relationship between cattle abundance and meat production;
4. The relationship between cattle abundance and north-south gradient location of sites.

The relative frequency of cattle in the zooarchaeological record. Taphonomic analysis of the bone assemblage from Tel Beer-Sheba, Stratum II, shows that three taphonomic agents—bone fragmentation during post-depositional processes, and bone breakage as well as bone collecting during the archaeological dig—are likely to cause overrepresentation of cattle in bone assemblages (see Chapter 5).

The relationship between the relative frequency of species in faunal assemblages, skeletal element size and methods of bone collecting in archaeological excavation has been frequently discussed in zooarchaeological studies (Payne 1975; Davis 1987a:29; Zeder 1991:103; Crabtree 1996:61; Zohar and Belmaker 2005; Grigson 2006:216). All studies show that when sieving was not practiced for retrieving zooarchaeological finds, the relative frequency of cattle remains increased compared to caprines. The reason for this is that cattle skeletal elements are 2–3 times larger than the same skeletal elements of sheep and goats. It is likely that the field archaeologist would fail to spot many small skeletal elements of caprines while the same skeletal elements of cattle would be collected. The archaeological and zooarchaeological project of Tel Hesban provided us with an evident example of this issue. The relative frequency of caprines and cattle was obtained from three different phases of sampling, census of live animals, bone collecting of faunal remains at the contemporary village of Hesban (LaBianca 1995b) and data on faunal remains from the adjacent ancient site (LaBianca 1995c; Ray 2001). The first phase (census),

represents the most reliable method to attain results on the relative frequency of species. The second phase (bone collecting), represents a moderately reliable method. Although animal bones were exposed and visible to the team collecting them at the village of Hesban, it would be reasonable to assume that some of the caprine bones were not collected due to their relatively smaller size. The last phase (zooarchaeological record), represents the most difficult and least reliable method. I calculated the proportion of cattle from the total numbers of caprines (sheep and goats) and cattle. The results are striking: while the relative frequency of cattle in the enumeration of live animals is 4% (30 out of 758 animals), it increases to 6.5% in the bone collecting phase (33 out of 510 bones) and ranges from 8.7% to 17.4% in the zooarchaeological record (Table 5.7).

To conclude, the relative frequency of cattle and the difficulty in retrieving the faunal data increases correspondingly due to the larger size of cattle skeletal elements. We should assume that the proportion of cattle in most faunal assemblages from the Bronze and Iron Age is lower than the actual NISP count.

Cattle abundance and intensification of agriculture

Baruch Rosen studied the economy of Izbet Sartah in the Iron Age. He associated cattle with plowing and asserted that where a zooarchaeological assemblage consists of 20% cattle bones or more, it points to an intensification of crop farming at the site (B. Rosen 1986:170). Redding provided us with a similar equation saying: 'I expect increasing intensification and specialization of agricultural production and alteration of the plant community to be associated with an increase in the number of cattle relative to other animals' (Redding 1993:86). Grigson (1995:259) suggested that the greater the number of cattle the more important the role of agriculture in the economy. Herzog (1994:126) attributes the relatively high proportions of cattle to prosperous periods when agricultural practices intensified and he attributes a decrease in cattle proportion to periods of economic decline. Finkelstein and Silberman (2001:115) state: 'bones collected at sites that flourished during periods of intense settlement in the highlands contain a relatively large proportion of cattle—which generally indicates extensive field farming and the use of the plow'. The equation suggested by Rosen and Redding associating the high proportion of cattle to the intensification of agriculture became a paradigm and has been cited by many scholars (Wapnish and Hesse 2000:439; Hesse and Wapnish 2001:253; Horwitz and Milevski 2001:284–5). This equation needs to be reassessed. Cattle should definitely be associated with agriculture. The question is whether a higher proportion of cattle indicates an intensification of dry farming. We shall test this question using some basic arithmetic operations. Herzog (1994) estimated that 300 people inhabited Stratum II of Tel Beer-Sheba. We may estimate a per capita wheat consumption of 180 kg per

annum (Groen *et al.* 1964:39; Hütteroth and Abdulfattah 1977:85; Avitsur 1977:36–7; Rosen 1994:347, for detailed nutritional computing see Sasson 1998:13–14). Thus, we may deduce 300 inhabitants would require 54,000 kg of grains per annum. We may estimate that the grain yield per dunam (1,000 sq m) was approximately 60 kg. (Volcani 1925:8; 1938:41–4; Horwitz and Hinden 1938:41; Russel 1946:120; Ilan 1974:25–7; Russell 1988:63). Thus, for producing 54,000 kg of grain, 900 dunam were required. Double oxen are capable of plowing approximately 100 dunam per annum (Pinner 1930; Avitsur 1977:36–7; B. Rosen 1986:169–70; Halstead 1995:15). We may assume that nine double oxen were required for plowing 900 dunam, namely, 18 oxen. The next step is estimating the composition of the cattle herd. Avitsur studied the use of the native ard in the land of Israel in the 20th century. He asserted that cattle were used first and foremost for plowing and that in an enumeration of cattle at the beginning of the 20th century, the ratio between oxen to cows was 2:1 (Avitsur 1965:27, see also B. Rosen 1994:347–8). If we assume a ratio of two-thirds oxen and one-third cows in of Tel Beer-Sheba, the cattle herd would comprise 27 individuals (18 oxen and 9 cows). In sum, a relatively small number of cattle was required for supporting full-scale dry farming and producing the required grains for the inhabitants. The estimate coincides with figures presented by Rosen (B. Rosen 1994), in an article discussing the agriculture of the Iron Age. According to Rosen, a site of 100 inhabitants required 8 to 12 heads of cattle to maintain the agricultural tasks. He also noted that around 300 sheep were required for providing the high-value proteins and calories essential for the inhabitants. Rosen concluded: ‘in this model the ratio of bovines to ovines is about 1:20’ (i.e. 5%; B. Rosen 1994:349). In sum, Rosen’s model supports the idea presented here: A relatively small number of cattle were required to maintain full-scale dry farming and the proportion of cattle certainly did not exceed 20% of the total livestock.

Cattle abundance and meat production. Grigson (1995), in a study of animal husbandry in the Southern Levant, argues that although the relative frequency of cattle bones in archaeological sites is low, cattle contribution to meat production was at least 50% of the total meat produced at the site. This idea is also advocated by Horwitz (2002:400). Grigson reached her results by multiplying the relative frequency of cattle and caprines by their average weight and concluded that: ‘sheep and goats take second place to cattle in all areas of the country’ (Grigson 1995:251). This conclusion ought to be reexamined.

For calculating meat production, Grigson adopted data on European breeds reported by Clark and Yi (1983:193). According to Grigson, the minimal live weight of cattle (*Bos taurus*) is 625 kg. However, Bodenheimer (1960:187) has already noted, five decades ago, that the local Middle Eastern cattle are considerably smaller than European cattle. Von den Driesch and Boessneck (1995:76) noted that cattle in the Iron Age were smaller than in the Roman

period or present time. The live weight of the local breed named *baladi* is 250 kg on average (Levy 1982:727; U. Levy 1983:5; Mason 1996:273; Borowski 1998:74–5; Sasson 2006:Table 1). We should note that while Grigson's numbers are of minimum weight, the numbers provided here are of an average live weight. Even then, the cattle Grigson is referring to in her calculations are 2.5 times bigger than the average Middle Eastern cattle. Apparently, these overestimated figures have biased the analysis of meat contribution towards cattle.

Making use of Rosen's case study (Rosen 1994) described above, we shall assume that 100 people that practiced dry farming as well as animal husbandry, required 300 sheep and 18 head of cattle. Assuming that the edible meat of one sheep is around 25 kg (Hirsch 1933; Sasson 1998), the sheep herd would provide 7,500 kg of meat ($300 \times 25\text{kg}$). As mentioned above, Avitsur (1965) and other scholars have argued that cattle were exploited primarily for labor (rather than for their meat or milk). Nonetheless, we shall assume that cattle, when no longer used for labor, were slaughtered and consumed. Assuming the edible meat per one head of cattle is around 120 kg (B. Rosen 1986; Sasson 1998:21 and see additional references there), the cattle herd would provide 2,160 kg of meat ($18 \times 120\text{kg}$). Based on this calculation, cattle provide merely 22% of the total meat, and it is apparent that caprines were the primary meat providers.

I do not oppose the idea that cattle were used for their meat. On the contrary, eliminating environmental constraints, cattle would represent the modern 'family pack' and would be the most suitable livestock for meat (and milk) production. Data compiled from the Food and Agriculture Organization of the United Nations (Statistical Yearbook 2004) show that: in the years 2000–2002, the per capita daily calorie intake of bovine meat in Israel was 104 Kcal while the meat intake of sheep and goats was only 8 Kcal. The present-day diet is clearly dominated by beef. This is a result of the fact that modern cattle breeds, which are much larger than the ancient cattle, receive unlimited water and fodder supplies. Moreover, with modern veterinary, cattle husbandry in present times is no longer a precarious task. What stood between ancient populations and using cattle as a main source of meat and milk was their struggle to minimize risks and fluctuations in the resource base. Thus, one should expect a relatively high frequency of cattle mostly in regions or periods that secure abundant subsistence resources for cattle (i.e. water and pasture). The discussion below, on carrying capacity, provides additional perspective on this issue.

Cattle abundance and north-south gradient location of sites. Tchernov and Horwitz (1990) examined the caprine/cattle ratio in archaeological sites in Israel. They argued that a trend in the relative frequency of cattle that follows the north-south gradient (i.e. moist in the north, arid in the south) could be observed: 'with lower caprovines frequencies in the north of the country

(roughly the Mediterranean region) and an increase in the more Southern regions' (Tchernov and Horwitz 1990:212). Tchernov and Horwitz divided the land of Israel into four geographical regions based on the carrying capacity of pasture as published by Seligman *et al.* (1959): region 1 includes the Upper Galilee and the Coastal Plain; region 2, the Upper Jordan Valley and the Western Foothills; region 3, the Carmel and the Central Hill; and region 4, the Northern Negev. Before examining their results, a methodological remark should be made; Tchernov and Horwitz list the sources of the zooarchaeological data though they do not exhibit the NISP (Number of Identified Specimens) count or data on the relative frequency of species per site. Lack of essential raw data makes a thorough reassessment of their work more complicated. Nonetheless, a review of the graphs presented in their paper (Tchernov and Horwitz 1990:212) may lead to different conclusions from those stated by the authors. For instance, the graph of the Early Bronze Age sites shows that the relative frequency of caprines in regions 1, 2, and 3 does not differ significantly. In the Iron Age I, the relative frequency of caprines is 70–80% in regions 2, 3, and 4 and in the Iron Age II, their relative frequency in these regions is 80–90%. Obviously, a significant interregional pattern, based on north-south gradient, does not emerge from these plots. Furthermore, in the Iron Age I and II, a similar proportion of caprines in the Northern Negev (region 4) and in the Mediterranean area (regions 1, 2, 3) can be observed. Tchernov and Horwitz (ibid:213) also argue that a temporal pattern in the relative frequency of caprines can be detected. For instance, in region 1, with the highest carrying capacity, they note that 'fairly constant' frequencies of caprines can be detected. However, the data from region 1 reveals the following: the relative frequency of caprines in the Neolithic period is 20%, 40% in the Chalcolithic, 60% in the Early Bronze Age, 20% in the Late Bronze, 60% in the Iron Age I and 30% in the Iron Age II. Obviously, a temporal pattern cannot be observed.

Species	RF		NISP		MNI	
	#	%	#	%	#	%
Caprines	60.2	85	3512	86	66	85
Cattle	10.9	15	568	14	12	15
Caprines + Medium mammal			9466	91.5		
Cattle + Large mammal			886	8.5		

Table 2.4 The proportion of cattle in Stratum II, Tel Beer-Sheba.

Stratum	Date	Type of Settlement	Count	Caprines	Cattle	Total	Cattle in %
Beer-Sheba IX	Iron Age I	Rural	NISP	303	28	331	8%
			MNI	14	4	18	22%
Beer-Sheba VIII		Rural	NISP	144	21	165	13%
			MNI	16	4	20	20%
Beer-Sheba VII		Rural	NISP	822	88	910	10%
			MNI	277	7	34	21%
Beer-Sheba VI		Rural	NISP	788	147	935	16%
			MNI	28	6	34	18%
Beer-Sheba V	Iron Age II	Urban	NISP	4252	566	4818	12%
			MNI	62	7	69	10%
Beer-Sheba IV		Urban	NISP	1617	279	1896	15%
			MNI	20	6	26	23%
Beer-Sheba III		Urban	NISP	1287	183	1470	12%
Beer-Sheba II		Urban	NISP	3512	568	4080	14%
			MNI	66	12	78	15%
Beer-Sheba H 3	Persian	Fortress	NISP	3976	366	4342	8%
			MNI	45	5	50	10%
Beer-Sheba H 2	Hellenistic/Roman	Fortress	NISP	1298	131	1429	9%
			MNI	20	3	23	13%
Beer-Sheba H 1	Early Roman	Palace	NISP	1111	95	1206	8%
			MNI	21	4	25	16%
NISP Average							11%
MNI Average							17%

Table 2.5 The proportion of cattle in the Beer-Sheba strata (I wish to thank Moshe Sade for allowing me to use some of the data in this table).

In sum, Tchernov and Horwitz’s conclusions do not coincide with the data they exhibited. A pattern of decline in the relative frequency of cattle that follows the north-south gradient cannot be detected. In some periods, the proportion of cattle in the Northern Negev and in the Mediterranean regions is similar.

Caprine/Cattle Ratio: Results

In the discussion above, I have reexamined four notions regarding cattle in the Bronze and Iron Age. My conclusions are: (a) cattle is overrepresented in the zooarchaeological record; (b) cattle abundance does not point to agricultural intensification; (c) cattle was not the primary source of meat; (d) trends in cattle abundance that follow the north-south gradient could not be observed. These ideas as well as the hypothesis of the survival subsistence strategy were examined in a comparative analysis of the zooarchaeological record from 70 sites and strata in the Southern Levant. The study comprises intra-site analysis (Tel Beer-Sheba), intra-regional analysis (the Northern Negev), interregional analysis and settlement type analysis.

Intra-site analysis: Cattle abundance in Tel Beer-Sheba (Table 2.5). In the first

phase, the relative frequency of cattle in 12 strata of Tel Beer-Sheba was examined using the two common counting methods: MNI (Minimum Number of Individuals) and NISP (Number of Identified Specimens). Table 2.5 shows that cattle proportion has not changed significantly during the 1200 years of occupation. It is striking that although Tel Beer-Sheba has changed dramatically throughout time, from a small village to a fortified town and later to a fortress and a palace (Herzog 1993; Herzog and Singer-Avitz 2006:165), the proportion of cattle remained low, ranging between 8 and 16% (11% on average). Many scholars have argued that livestock were used as a segment of trade in a market economy system. If market-economy was prevalent in Tel Beer-Sheba one would expect to observe significant changes in the relative frequency of caprines and cattle that followed the dramatic changes in the character of the site. Conversely, if we assume that the economy of Tel Beer-Sheba was self-sufficient and the survival subsistence strategy was maintained throughout time, the minor changes in cattle abundance are not surprising. The data in Table 2.5 supports the notion of survival subsistence strategy.

Site and Strata	Period	Region	Type of Settlement	Cattle in %	Reference
Beer-Sheba II	IA II	Northern Negev	Urban	14	SASSON, HERE
Beer-Sheba IX-VI	IA I	Northern Negev	Rural	14	HELLWING 1954
Halil	EB III	Northern Negev	Urban	6	ZEDER 1990
Halif	LB	Northern Negev	Urban	16	ZEDER 1990
Itahf	IA II	Northern Negev	Urban	15	ZEDER 1990
Hesban	1970	Jordan	Rural	4	LABIANCA 1995b
Hesban II-III	Mamluk	Jordan	Rural	14	LABIANCA 1990+1995a
Hesban XI-XIV	Roman	Jordan	Rural	11	LABIANCA 1990+1995a
Hesban XV-XVII	IA II	Jordan	Rural	9	LABIANCA 1990+1995a
Hesban XVII-XXI	IA I	Jordan	Rural	17	LABIANCA 1990+1995a
Nahal Besor	Islamic	Northern Negev	Rural	0	NACHLIELI 1999
Nahal Omer	Islamic	Negev	Rural	0	NACHLIELI 1999
Masos	IA I	Northern Negev	Rural	24	TCHERNOV-DRORI 1983
Ira	IA II	Northern Negev	Urban	11	DAYAN + HORWITZ 1999b
Arad	EB	Northern Negev	Urban	7	DAVIS 1976+LERNAU 1978
Arad VI-XII	IA II	Northern Negev	Fortress	8	SADE 1988
Qimrit	IA II	Northern Negev	Cultic	7	HORWITZ RAPHAEL 1995
Average				10	

Table 2.6 The proportion of cattle in Northern Negev sites and Hesban (Jordan).

Intra-regional analysis: cattle abundance in the Northern Negev sites (Table 2.6). In the second phase of the analysis, the Northern Negev (including data from Tel Beer-Sheba) sites were examined (Table 2.6, Figure 2.1). Data from Hesban, which is located in a similar environmental setting, is included as well. The data from Hesban comprises the ancient strata (LaBianca 1990; 1995c) as well as faunal data from the contemporary village (LaBianca 1995b). Most sites date to the Iron Age and others to the Early Bronze Age (Tel Arad), the

Late Bronze Age (Tel Halif), Roman period (Hesban, strata XI-XIV) and the Islamic period (Nahal Besor). The Northern Negev sites represent diverse settlement types; Hurvat Qitmit is a cultic site, Hurvat Uza is a fortress, Tel Arad is urban, and Tel Hesban, throughout all periods, represents a rural settlement.

Table 2.6 reveals that the average proportion of cattle is 10% and the maximum is 17% (with the exception of Tel Masos which will be discussed below). It is striking that cattle proportion does not vary dramatically regardless of period or type of settlement. Boessneck and Von den Driesch (1978:263) pointed out that the cattle proportion in the Iron Age strata of Hesban is considerably higher than its proportion in present days (13% and 4% respectively). They attribute this decline to overgrazing and landscape degrading in antiquity. They also note that cattle in contemporary Hesban are fed with fodder. The premise of overgrazing and its negative effect on rangeland has been challenged by Avi Perevolotsky. He studied this issue in the Northern Negev and concluded:

The most significant observation is that heavy grazing does not entail a negative effect on production over the years. In other words, the production in each individual year is, first of all, an outcome of the specific conditions (rainfall amount and distribution, solar radiation and nutrient availability) and not of biological damage imposed by previous heavy grazing (Perevolotsky 1995:12, see also Perevolotsky and Seligman 1998).

Thus, we may attribute the decline in cattle proportion in Tel Hesban to overrepresentation of cattle in faunal assemblages and to the survival subsistence strategy (see above the discussion on both topics).

The relative frequency of cattle in Tel Masos is slightly higher than other Northern Negev sites. Herzog (1994:126) attributes this to the intensification of dry farming in the Iron Age IIA. As shown above, a high percentage of cattle does not necessarily point to intensification of agriculture. If oscillations in the proportion of cattle was related to climatic conditions (Herzog and Singer-Avitz 2004:234), one would expect to find this pattern in other sites of the same period. Tables 2.5 and 2.6 clearly show that apart from Tel Masos, the relative frequency of cattle in Tel Beer-Sheba strata and other Northern Negev sites is rather stable. The relatively high percentage of cattle in Tel Masos may be attributed to the relatively small sample of bones that was studied (676 identified specimens in all three strata), coupled with the possible overrepresentation of cattle in the assemblage.

In sum, cattle proportion in the Northern Negev sites coincide with the data from the Tel Beer-Sheba strata; it disproves the notion of market economy and points to a self-sufficient economy in all settlement types and all periods.

Cattle proportion in urban sites (Table 2.7, Figure 2.4). The analysis of the Tel Beer-Sheba strata and the Northern Negev sites indicates that cattle percentage is relatively low regardless of settlement type (urban or rural). The relationship between the proportion of cattle and settlement type was addressed using a

larger sample of sites from various regions. The data was compiled from 30 sites that were defined as urban (e.g. city wall, public buildings) (Table 2.7). The sites represent various regions (the Northern Negev, Central Hills, Shephelah, Coastal Plain, and the Northern Valleys) and periods (mostly the Bronze and Iron Age as well as the Roman period).

<i>Site and Strata</i>	<i>Period</i>	<i>Region</i>	<i>Type of Settlement</i>	<i>Cattle in %</i>	<i>Reference</i>
Halif	EB III	Northern Negev	Urban	6	ZEDER 1990
Uza	IA II	Northern Negev	Fortress	7	SADE 1988
Arad	EB	Northern Negev	Urban	7	DAVIS 1976+LERNAU 1978
Arad VI-XII	IA II	Northern Negev	Fortress	9	SADE 1988
Yarmouth	EB	Central Hill	Urban	11	DAVIS 1988
Ira	IA II	Northern Negev	Urban	11	DAYAN + HOKWITZ 1989b
Lachish VIII	MB	Shephelah	Urban	12	DROBI 1979
Shiloh	MB II-III	Central Hill	Urban	12	HELLWING 1993
Beer-Sheva II	IA II	Northern Negev	Urban	14	SASSON, HERF
Halif	IA II	Northern Negev	Urban	15	ZEDER 1990
City of David	IA II	Central Hill	Urban	15	HOKWITZ 1996b
Halif	LB	Northern Negev	Urban	16	ZEDER 1990
Average				11	
Megiddo	EB I	Northern Valleys	Urban	19	WAPNISH HESSE 2000
Lachish III IV	IA II	Shephelah	Urban	21	DROBI 1979
Dulit	EB II	Shephelah	Urban	24	HOKWITZ, ET AL. 1999
Kabri	IA II	Coastal Plain	Fortress	25	HOKWITZ 2002
Megiddo	EB III	Northern Valleys	Urban	25	WAPNISH HESSE 2000
Mique	IA II	Shephelah	Urban	27	LEV-TOV 2000
Mique	LB	Shephelah	Urban	28	LEV-TOV 2000
City of David	Roman	Central Hill	Urban	29	HOKWITZ 1996b
Harasim IVb	IA II	Shephelah	Urban	30	MAHER 1999
Lachish VI	LB	Shephelah	Urban	30	DROBI 1979
Kunet	LB	Northern Valleys	Urban ?	32	HELLWING 1988/9
Kunet	LB	Northern Valleys	Urban ?	32	HELLWING 1988/9
Harasim IVd	IA II	Shephelah	Urban	34	MAHER 1988
Aphik	MB II	Coastal Plain	Urban	40	HELLWING-GOPHNA 1984
Dan (Tel)	FB II-III	Northern Valleys	Urban	42	WAPNISH-HESSE 1991
Kabri	EB	Coastal Plain	Urban ?	44	HOKWITZ 2002
Gerisa	LB I II	Coastal Plain	Urban	55	SADE 2001
Mique	IA I	Shephelah	Urban	56	LEV-TOV 2000
Average				33	

Table 2.7 The proportion of cattle in urban sites.

The percentage of cattle, as it appears in Table 2.7, may be divided into two clusters: the upper table includes sites with cattle proportion that ranges from 6% to 16% (11% on average) and the lower table, sites with cattle proportion that ranges from 19% to 55% (33% on average). The latter cluster will be discussed in the interregional analysis.

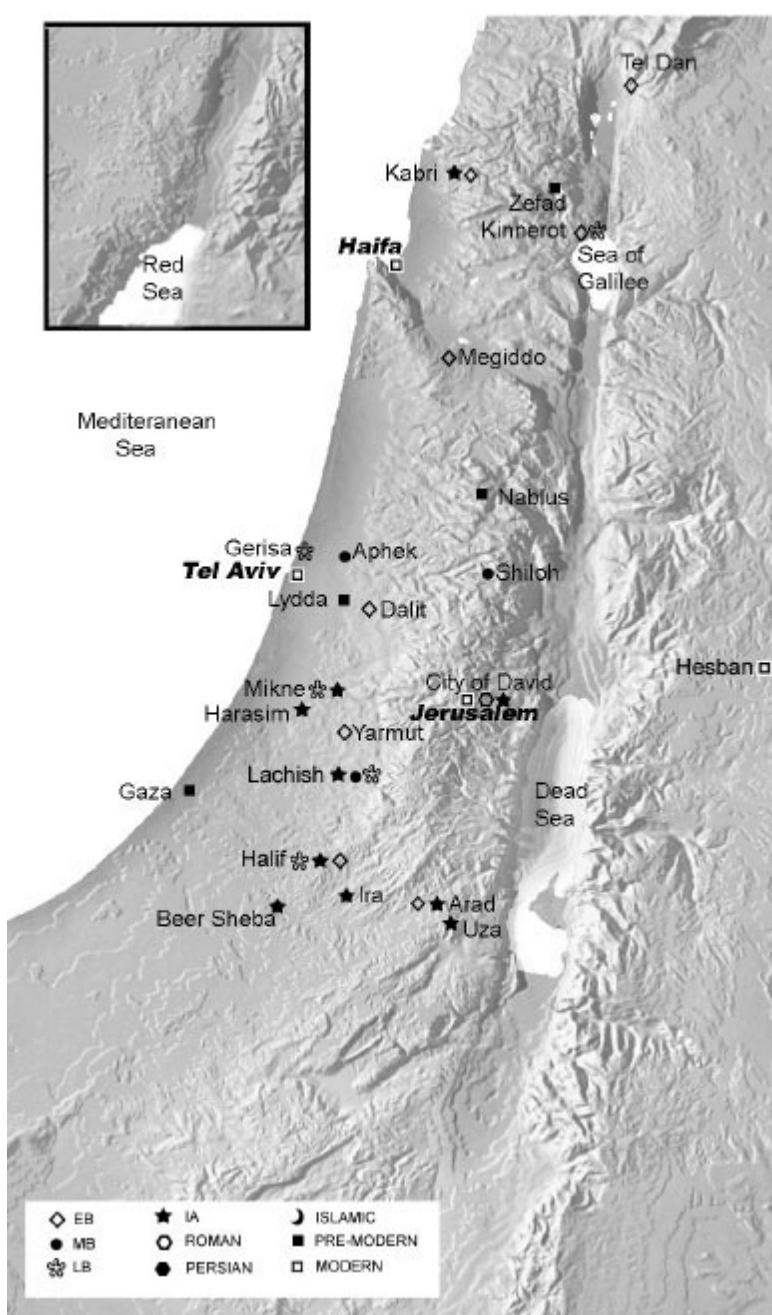


Figure 2.4 Urban sites (based on a map created by Digital Wisdom®).

As discussed above, cattle rearing is a relatively complicated task due to their need for extensive pasturage and large quantities of water (Dahl and Hjort 1976:239–43, see above for more references). It would be reasonable to assume that urban sites, which were governed by ruling classes (Herzog 1997:13; Hopkins 1996:128; Lemche 1996; LaBianca 1999:21; Faust 2000), had

control over larger water and pasture resources and for this reason, the proportion of cattle there would be significantly higher than in other sites. The data from the first cluster in [Table 2.7](#) negate this hypothesis. The 12 urban sites in the first cluster show a low proportion of cattle—11% on average. [Table 2.7](#) also shows a cluster of sites with a high percentage of cattle, a fact which may support this hypothesis. However, I argue that the reason for high proportions of cattle in these sites should be attributed to their geographical location rather than their urban character. If a high percentage of cattle was related to the urban factor, this pattern would be observed in all urban sites. Other evidence, supporting my argument on a regional pattern, will be discussed below. Yet, before presenting the regional analysis, I shall discuss the caprine/cattle ratio in rural sites.

<i>Site and Strata</i>	<i>Period</i>	<i>Region</i>	<i>Type of Settlement</i>	<i>Cattle in %</i>	<i>Reference</i>
Avnon	MB I	Southern Negev	Rural	0	HAKKER-ORION 1999
Eilor	Islamic	Southern Negev	Rural	0	HORWITZ 1998
Nahal La'anah	Islamic	Southern Negev	Rural	0	NACHLIELI 1999
Nahal Mitnan	Islamic	Southern Negev	Rural	0	HORWITZ 1995
Ein Ziq	MB I	Southern Negev	Rural	0	HAKKER-ORION 1999
Nahal Be'er	Islamic	Northern Negev	Rural	0	NACHLIELI 1999
Nahal Omer	Islamic	Northern Negev	Rural	0	NACHLIELI 1999
Be'er Resisim	MB I	Southern Negev	Rural	1	HAKKER-ORION 1999
Hesban	1970	Jordan	Rural	4	LABIANCA 1995b
Shiloh	LB	Central Hill	Rural	9	HELLWING 1993
Hesban XV-XVII	LA II	Jordan	Rural	9	LABIANCA 1990 + 1995a
City of David	LA I	Central Hill	Rural	10	HORWITZ 1996b
Hellon (District)	1943	Central Hill	Rural	11	GOV. OF PALESTINE 1943
Hesban II-III	Mamluk	Jordan	Rural	14	LABIANCA 1990 + 1995a
Qasile	LA I	Coastal Plain	Rural	14	DAVIS 1985
Beer-Sheva IX-VI	LA I	Northern Negev	Rural	14	HELLWING 1984
Qiri	LA II	Northern Valleys	Rural	15	DAVIS 1987b
Ai - Raddana	LA I	Central Hill	Rural	17	HESSE 1999
Hesban XVIII-XXI	LA I	Jordan	Rural	17	LABIANCA 1990 + 1995a
Average				7	
Shiloh	LA I	Central Hill	Rural	23	HELLWING 1993
Yaqush	FB I	Northern Valleys	Rural	23	HESSE-WAPNISH 2001
Masos	LA I	Northern Negev	Rural	24	TOHERNOV-DRORI 1983
Yaqush	LB II	Northern Valleys	Rural	24	HESSE-WAPNISH 2001
Gaza (District)	1943	Coastal Plain	Rural	26	GOV. OF PALESTINE 1943
Zefad (District)	1943	Galilee	Rural	27	GOV. OF PALESTINE 1943
Michal	LA	Coastal Plain	Rural	34	HELLWING-FEIG 1989
Yaqush	FB III	Northern Valleys	Rural	34	HESSE-WAPNISH 2001
Michal	Persian	Coastal Plain	Rural	39	HELLWING-FEIG 1989
Izbot Zarta	LA	Coastal Plain	Rural	39	HELLWING 1986
Lod (District)	1943	Coastal Plain	Rural	42	GOV. OF PALESTINE 1943
Gerisa	LA I	Coastal Plain	Rural	45	SADE 2001
Michal	LB	Coastal Plain	Rural	47	HELLWING-FEIG 1989
Dan (Tel)	LA II	Northern Valleys	Rural	54	WAPNISH-HESSE 1991
Average				34	

Table 2.8 The proportion of cattle in rural sites.

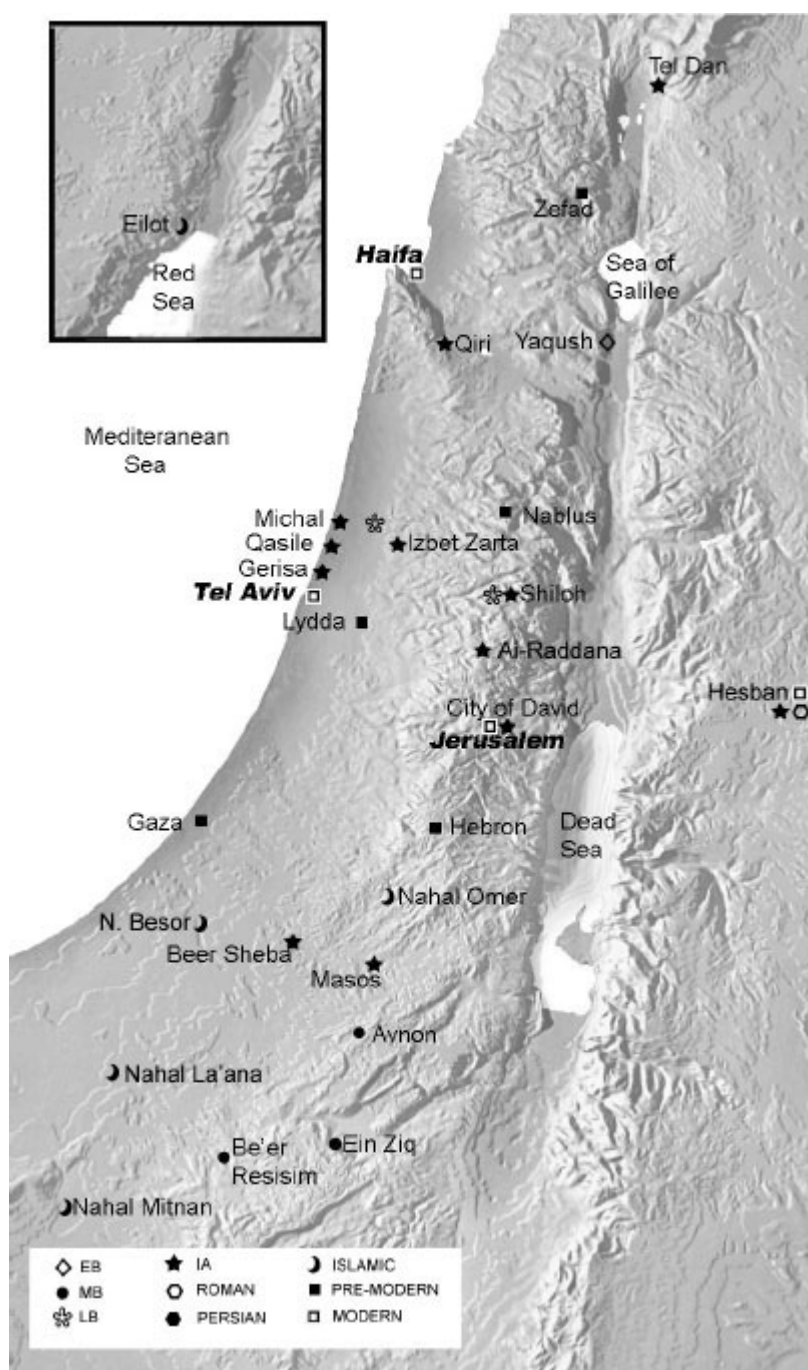


Figure 2.5 Rural sites (based on a map created by Digital Wisdom®).

Cattle proportion in rural sites (Table 2.8, Figure 2.5). Data on caprine/cattle ratio was studied in 34 rural sites. The sites represent various geographical regions (Southern and Northern Negev, Central Hill, Coastal Plain and

Northern Valleys) and periods (Bronze and Iron Age, Roman and Islamic periods). Ethnographic data from present-time rural sites (the village of Hesban in Jordan and data from mandatory Palestine) was studied as well. No homogeneous pattern could be identified among the rural sites. The data in [Table 2.8](#) points to a similar pattern as in the urban sites. The sites cluster into three groups: those with a low cattle proportion (0%–1%, lower section of [Table 2.8](#)); those with a relatively low cattle proportion (7% on average); and sites with a high cattle proportion (34% on average, see upper section of [Table 2.8](#)). [Tables 2.7](#) and [2.8](#) clearly indicate that the common characteristic of urban and rural sites with a low cattle percentage is regional. The same regional pattern arises in urban and rural sites with a high proportion of cattle.

Site and Strata	Period	Region	Type of Settlement	Cattle in %	Reference	Adult Cattle
Avnon	MB I	Southern Negev	Rural	0	HAKKER-ORION 1999	X
Eilat	Islamic	Southern Negev	Rural	0	HORWITZ 1998	X
Nahal Laianah	Islamic	Southern Negev	Rural	0	NACHLIELI 1999	X
Nahal Mitnan	Islamic	Southern Negev	Rural	0	HORWITZ 1995	X
Ein Ziq	MB I	Southern Negev	Rural	0	HAKKER-ORION 1999	X
Timna	LB	Southern Negev	Cultric	0	LEFNAU 1988	X
Be'er Resisim	MB I	Southern Negev	Rural	1	HAKKER-ORION 1999	X
Nahal Omer	Islamic	Southern Negev	Rural	0	NACHLIELI 1999	X
Average				0		

Table 2.9 The proportion of cattle in the Southern Negev sites.
X: No available data

Caprine/cattle ratio: interregional analysis. The data from 70 faunal datasets point to three clusters of sites:

1. Sites where the cattle are either absent or present in negligible numbers. These sites are situated in the Southern Negev ([Table 2.9](#)).
2. Sites where the cattle proportion is 13% on average. These sites are located in the Northern Negev (including Hesban, Jordan) and the Central Hills ([Table 2.10](#)).
3. Sites where the cattle proportion is relatively high—33% on average. These sites are found in the Coastal Plain, the Shephelah and the Northern Valleys ([Table 2.11](#)).

The Southern Negev sites ([Table 2.9](#)). This group of sites is relatively small and includes merely eight sites due to limited zooarchaeological data from this region. The sites represent various sub-regions; the Arava, Timna Valley and the Negev Highlands, as well as various periods: the Middle Bronze and Late Bronze Age and the Islamic period. The data in [Table 2.9](#) is homogeneous, cattle are absent from almost all sites. As I argue below, the primary use of cattle in antiquity was for plowing (Sasson 2005a). The absence of cattle remains from the Southern Negev may imply that either dry farming was not

practiced or cattle were not used for plowing in this region. As shown above, dry farming was practiced in the Southern Negev (Amiran and Ben-Arieh 1963; Nachlieli 1999:289–301 and see more references in the discussion above). We may therefore assume that plowing tasks in the Southern Negev were carried out in earlier periods by man and in the Islamic periods, by camels.

The Northern Negev and the Central Hill sites (Table 2.10). Comparative analysis of 30 faunal datasets was carried out in this phase. The sites represent periods of all three phases of the Bronze Age, the Iron Age I and II, the Roman and Islamic periods as well as ethnographic data from contemporary sites. The mean percentage of cattle in the Northern Negev and Central Hill sites is 13%. In most sites (n=27) the proportion of cattle does not exceed 17%. We should note that in a small number of sites (n=5), the proportion ranges from 23% to 29% and these do not match the pattern proposed here. Nonetheless, this small group does not negate the pattern outlined by 84% of the sites. Furthermore, as discussed above, a high percentage of cattle in zooarchaeological assemblages might be a result of a small sample, methods of bone collecting in the field or a combination of both.

A striking fact is that similar proportions of cattle is found in the Northern Negev and the Central Hills sites, despite the different climatic conditions. The average annual rainfall in the Northern Negev is approximately 200 mm (Evenari *et al.* 1971:29–37) while in the Central Hill country it is approximately 600 mm (Lev-Yadun 1997). One would expect a higher percentage of cattle in a region with a significantly higher precipitation levels. The similar cattle proportions in both regions should be addressed.

<i>Site and Strata</i>	<i>Period</i>	<i>Region</i>	<i>Type of Settlement</i>	<i>Cattle in %</i>	<i>Carrying Capacity</i>	<i>Reference</i>	<i>Adult Cattle</i>
Nahal Besor	Islamic	Northern Negev	Rural	0	7	NACHLIELI 1999	X
Nahal Omer	Islamic	Negev	Rural	0	7	NACHLIELI 1999	X
Qa'agir (Tomb)	MB I	Central Hill	Burial	1	24	HORWITZ 1987	X
Hesban	1970	Jordan	Rural	4	7	LABIANCA 1995b	X
Halif	EB III	Northern Negev	Urban	6	7	ZEDER 1990	X
Uza	IA II	Northern Negev	Fortress	7	7	SADE 1988	A
Arad	EB	Northern Negev	Urban	7	7	DAVIS 1976 + LERNAU 1978	X
Qitmit	IA II	Northern Negev	Cultric	7	7	HORWITZ-RAPHAEL 1995	Y
Shiloh	LB	Central Hill	Rural	9	24	HELLWING 1993	A
Sasa (Tomb)	MB II	Galilee	Burial	9	31	HORWITZ 1987	X
Hesban XV-XVII	IA II	Jordan	Rural	9	7	LABIANCA 1990 + 1995a	A
Arad VI-XII	IA II	Northern Negev	Fortress	9	7	SADE 1988	A
City of David	IA I	Central Hill	Rural	10	24	HORWITZ 1996b	X
Yarmouth	EB	Central Hill	Urban	11	24	DAVIS 1988	X
Hesban XI-XIV	Roman	Jordan	Rural	11	7	LABIANCA 1990 + 1995a	A
Ira	IA II	Northern Negev	Urban	11	7	DAYAN + HORWITZ 1999b	A
Shiloh	MB II-III	Central Hill	Urban	12	24	HELLWING 1993	A
Hesban II-III	Mamluk	Jordan	Rural	14	7	LABIANCA 1990 + 1995a	A
Beer-Sheba II	IA II	Northern Negev	Urban	14	7	SASSON, HERE	A
Beer-Sheba IX-VI	IA I	Northern Negev	Rural	14	7	HELLWING 1984	A
City of David	IA II	Central Hill	Urban	15	24	HORWITZ 1996b	X
Halif	IA II	Northern Negev	Urban	15	7	ZEDER 1990	X
Halif	LB	Northern Negev	Urban	16	7	ZEDER 1990	X
Ai - Raddana	IA I	Central Hill	Rural	17	24	HESSE 1999	X
Hesban XVIII-XXI	IA I	Jordan	Rural	17	7	LABIANCA 1990 + 1995a	A
Shiloh	IA I	Central Hill	Rural	23	24	HELLWING 1993	A
Masos	IA I	Northern Negev	Rural	24	7	TCHERNOV-DRORI 1983	A
M. Eibal	IA I	Central Hill	Cultric	25	24	HORWITZ 1986/7	A
Zefad (District)	1943	Galilee	Rural	27	31	GOV. OF PALESTINE 1943	X
City of David	Roman	Central Hill	Urban	29	24	HORWITZ 1996b	X
Average				12			

Table 2.10 The proportion of cattle in the Northern Negev and Central Hill sites.

X: No available data; A: cattle culled at an adult age; Y: evidence for culling cattle at young age

Before discussing this issue, I shall elaborate on the general pattern of cattle proportion as it appears in both regions. The relative frequency of approximately 15% cattle is common not only in Israel but in many sites in the ancient Near East. This pattern may be observed in the Tel Beer-Sheba strata and the Northern Negev sites. Rosen provides us with ethnographic data from Middle Eastern countries: Israel, Jordan, Lebanon and Syria. Most sources point to a cattle proportion of approximately 15%. In addition, most epigraphic sources of Assyrian tax lists and economic documents from Ugarit, compiled

by Rosen, point to a cattle percentage of less than 15% (B. Rosen 1986:160–5). Buitenhuis (1990:199) points out this pattern in many zooarchaeological assemblages from Anatolia, Syria, Iraq and Jordan. Zeder (1991:50), provides us with data from an animal census carried out in Iran in the 1960s. Cattle are found in many sites throughout the ancient Near East, yet, in small numbers. This phenomenon needs to be addressed in light of the survival subsistence strategy, which represents an equilibrium between two factors. The first factor is the extensive pasturage and water requirements for cattle, which made cattle husbandry a complicated task and a precarious investment. Cattle endangered the subsistence resources and if this was the only factor to consider, cattle would be absent from most Bronze and Iron Age sites. Nonetheless, cattle bones have been found at numerous sites. The reason behind that relates to the second factor: cattle were essential for plowing (Jochim 1981:42; Mazar 1992:118) and for the production of grain, a primary source of carbohydrates and a principal component in the ancient diet (Sasson 2006; Rolfes *et al.* 2006:104–8). Cattle, in ancient records are mentioned primarily as plow beasts. Borowski (1987:51–2) provides us with evidence from Biblical sources, Stol (1995:175–6) from Old Babylonian texts and van Driel (1995) from Neo-Babylonian texts (see also Heimpel 1995:134–5).

Additional evidence for the use of cattle as plow beasts may be found in cattle mortality profiles in zooarchaeological assemblages. Cattle were put to work only when reaching adulthood at 3–4 years of age (Sherratt 1981; Davis 1987a:162–4; Horwitz 1989a:49; Zeder 1991:29; Landon 1992:353; Halstead 1995; Sasson 2005a:217–18). Thus, culling cattle at an adult age should indicate their use for plowing. Data on the mortality profiles of cattle is presented in [Tables 2.9](#), [2.10](#) and [2.11](#). It should be noted that not all zooarchaeological reports provide data on mortality profiles. In 34 (89%) out of 37 sites and strata with relevant data, the mortality profiles point to the culling of cattle at an adult age. This strongly suggests cattle were used primarily for labor.

We may note two additional reasons associated with the survival subsistence strategy and the low percentage of cattle in regions where subsistence resources were limited. The body mass of cattle equals the body mass of approximately five sheep/goats (Seligman *et al.* 1959:26–7; Horwitz and Tchernov 1989:287–8). The dependence on a small number of animals with large body masses rather than a large number of animals with smaller body mass increases instability. I shall make use of Rosen's model to demonstrate this idea. The Subsistence base of a site of 100 inhabitants is 300 sheep/goats and 12 cattle (Rosen 1994:349). The death of 12 head of cattle, due to plague or drought, eliminates the whole herd. However, the death of either an equal number of caprine heads (12) or an equal number in body mass (60) would not obliterate the entire subsistence resources and would enable the inhabitants to rebuild the herd to its original size and sustain their survival. This notion, coupled with the fact that caprines cope more successfully than cattle with a harsh environment, supports the strategy of keeping cattle at a low proportion.

The second reason for keeping a high proportion of sheep/goats and a limited number of cattle was noted by Dahl (1979:42): ‘when small stock are slaughtered, the meat can readily be consumed by a single family, whereas the problems of storage and transport of the large amounts of meat from slaughtered cattle means that when cattle are killed, meat is generally distributed to a large number of people’ (see also Brown 1971:96). Clearly, subsisting primarily on sheep and goats rather than cattle coincides with the survival subsistence strategy. In sum, 15% cattle in many sites in the ancient Near East represent the equilibrium between the need to minimize risks and preserve the resource base and the need for plow beasts. As shown above, a relatively small number of cattle is sufficient for maintaining dry farming. Premising that cattle rearing was aimed primarily at plowing and dry farming, we should return to the question presented earlier in this chapter: why cattle were relatively abundant in the Northern Negev of Bronze and Iron Age and practically absent among contemporary Bedouins? Evidently, camels were used for plowing as well as for transportation (Marx 1967:94; Bulliet 1990:176; Ben David 1982:92; Avitsur 1965:26; Ben David and Orion 1998:188). Clearly, camels are better adapted to the desert than cattle thus more suitable for maintaining the survival subsistence strategy (Evenari *et al.* 1971:309; Kohler 1984; Clutton-Brock 1987:124–5; Dahl and Hjort 1976:246–8). The shift from cattle to camels requires an elaborated investigation that is beyond the scope of this study. A starting point in investigating this shift may be the fact that while only small number of camel bones was found in sites from the Late Bronze (Wapnish 1984) and Iron Age (Sasson 2005a; Wapnish 1984) their remains increase in the Babylonian and Persian periods and in sites from the Islamic periods, the relative frequency of camel bones ranges from 5% to 25% (Horwitz 1995; 1998; Nachlieli 1999).

In conclusion, since cattle was essential for plowing and dry farming in the Bronze and Iron Age, their remains are found in most zooarchaeological assemblages, yet, in low numbers. When camels became widespread, cattle importance diminished. Cattle husbandry, in many regions of the Middle East, stood in contrast with the survival subsistence strategy and in regions where water and pasture were limited (e.g. the Negev Desert), the presence of cattle diminished.

Cattle proportion in the lowlands (Table 2.11). The geographical term ‘lowlands’ that is used in this work includes three regions: the Northern Valleys, Coastal Plain and the Shephelah (Figure 2.2). The Northern Valleys region includes sites from the Jezrael Valley (e.g. Megiddo), Sea of Galilee region (e.g. Tel Kinrot) and Hula Valley (e.g. Tel Dan, Figure 2.1). The data was compiled from 31 sites and strata that represent the three phases of the Bronze Age, the Iron Age I and II as well as the Persian period and the period of Mandatory Palestine (Gaza and Lod districts located in the Coastal Plain region).

The pattern that emerges from Table 2.11 is apparent; cattle proportion in 30 of 31 sites is more than 15%. In 24 sites, the cattle proportion is 25% or more. Evidently, the data in Table 2.9, 2.10 and 2.11 indicate a regional pattern, which was statistically verified. Cattle proportion was statistically tested on three variants: settlement type (urban or rural), geographical location and the combination of both. The statistical test (two way ANOVA) was carried out on material from Arcsin, $\sqrt{p}$ = where 'p' is the cattle proportion at the site (in order to achieve a normal division). No significant difference was found between the cattle proportion and settlement type ($p = 0.694$). Likewise, no interaction was found between the cattle proportions, settlement type and geographical location ($p = 0.523$). However, a significant difference was found between the cattle proportions and geographical location ($p < 0.001$). In other words, the major differences in cattle proportion in the Bronze Age are due regional factors rather than settlement type or period. Prima facie, a high percentage of cattle should stand in contrast with the survival subsistence strategy in all regions. However, as portrayed above, this strategy is maintained when ecological conditions (for cattle husbandry in this model) are scarce and unstable. Hence, in regions where carrying capacity for cattle is adequate, one should not predict low proportions of cattle. This is well demonstrated when examining the contribution of beef to the modern diet. Evidently, cattle husbandry at the present time is highly developed. As a result, the per capita daily calorie intake from beef in Modern times is over ten times more than caprine meat (Statistical Yearbook 2004). This fact clearly supports the idea that periods or regions with high carrying capacity for cattle would be reflected with, a relatively high proportion of cattle.

Site and Strata	Period	Region	Type of Settlement	Cattle in %	Carrying Capacity	Reference	Adult Cattle
Kabri	IA II	Coastal Plain	Fortress	25	45	HORWIRZ 2002	A
Gaza (District)	1943	Coastal Plain	Rural	26	45	GOV. OF PALESTINE 1943	X
Michal	IA	Coastal Plain	Rural	34	45	HELLWING-FEIG 1989	A
Michal	Persian	Coastal Plain	Rural	39	45	HELLWING-FEIG 1989	A
Izbet Zarta	IA	Coastal Plain	Rural	39	45	HELLWING 1986	A
Aphek	MB II	Coastal Plain	Urban	40	45	HELLWING-GOPHNA 1984	A
Lod (District)	1943	Coastal Plain	Rural	42	45	GOV. OF PALESTINE 1943	X
Kabri	EB	Coastal Plain	Urban ?	44	45	HORWIRZ 2002	A
Gerisa	IA I	Coastal Plain	Rural	45	45	SADE 2001	A
Michal	LB	Coastal Plain	Rural	47	45	HELLWING-FEIG 1989	A
Gerisa	LB I-II	Coastal Plain	Urban	55	45	SADE 2001	A
Qutri	IA II	Northern Valleys	Rural	15	41	DAVIS 1987b	X
Megiddo	EB I	Northern Valleys	Urban	19	41	WAPNISH-HESSE 2000	Y
Yaqush	EB II	Northern Valleys	Rural	24	54	HESSE-WAPNISH 2001	X
Dan (Tomb)	MB	Northern Valleys	Burial	25	54	HORWITZ 1996a	A
Megiddo	EB III	Northern Valleys	Urban	25	41	WAPNISH-HESSE 2000	Y
Kinrot	EB	Northern Valleys	Urban ?	32	54	HELLWING 1988/9	A
Kinrot	LB	Northern Valleys	Urban ?	32	54	HELLWING 1988/9	A
Yaqush	EB III	Northern Valleys	Rural	34	54	HESSE-WAPNISH 2001	X
Dan (Tel)	EB II-III	Northern Valleys	Urban	42	54	WAPNISH-HESSE 1991	A
Dan (Tel)	IA II	Northern Valleys	Rural	54	54	WAPNISH-HESSE 1991	A
Lachish VIII	MB	Shephelah	Urban	12	42	DRORI 1979	X
Lachish III-IV	IA II	Shephelah	Urban	21	42	DRORI 1979	X
Dalit	EB II	Shephelah	Urban	24	42	HORWITZ, ET AL. 1999	A
Miqne	IA II	Shephelah	Urban	27	42	LEV-TOV 2000	A
Miqne	LB	Shephelah	Urban	29	42	LEV-TOV 2000	A
Harasim IVb	IA II	Shephelah	Urban	30	42	MAHER 1999	A
Lachish VI	LB	Shephelah	Urban	30	42	DRORI 1979	X
Harasim IVd	IA II	Shephelah	Urban	34	42	MAHER 1998	A
Miqne	IA I	Shephelah	Urban	56	42	LEV-TOV 2000	A
Average				33			

Table 2.11 The proportion of cattle in the lowlands.

X: No available data; A: cattle culled at an adult age; Y: evidence for culling cattle at young age

Cattle proportion and carrying capacity. In order to reassess the regional pattern, cattle frequencies were also tested against the carrying capacity of various regions. Seligman *et al.* (1959:15–27) studied the carrying capacity in most regions of Israel and noted that a basic animal unit (one mature cow weighing 450 kg) requires forage equal to 135 kg of barley per month. This means that one cow requires 135 feed units per month. The authors surveyed and quantified the vegetation composition in 13 regions in Israel, and calculated the amount of feed units available in each region. Carrying capacity can be thus defined as the amount of feed units per dunam (0.1 hectare). For example, the mean carrying capacity of all regions is 31 feed units per dunam. The carrying capacity values of each region are presented in Tables 2.10 and

2.11. The Upper Jordan valley (included here in the Northern Valleys area, see Figure 2.2, Table 2.11) has the highest carrying capacity (54 feed units) and the Northern Negev (Figure 2.2, Table 2.10) has the lowest carrying capacity (seven feed units). The correlation (Zar 1996:371–9) between the carrying capacity and the frequency of cattle was statistically tested. A strong and positive correlation was found between the two sets of values ($r = 0.74$, $p < 0.05$). This statistical correlation supports the regional pattern presented above and refines it. This leads us to the question: why is the proportion of cattle in the Central Hill region relatively low? One would predict a high carrying capacity in a region with dense herbaceous coverage and moist climate. However, the carrying capacity in this region is only 24 feed units (Table 2.10), considerably lower than the national average (31 units). Seligman *et al.* (1959:XI) refer to this issue stating: ‘The vegetation in the Mediterranean zone varies from open grasslands to close maquis and forest. The various open pasture types, that consist mainly of herbaceous vegetation cover 38% of the surveyed area and produce 67% of the pasture forage. The maquis and forest types cover 31% of the surveyed area but produce only 19% of the total pasture forage.’ In other words, despite the rich herbaceous coverage, the Central Hill region encompasses relatively small areas suitable for cattle forage and as a result, the carrying capacity for cattle is low. The authors underline the fact that if carrying capacity would be measured only for goats, it would most likely be higher than the carrying capacity for cattle (Seligman *et al.* 1959:54). Therefore, high proportions of cattle in the Central Hill region would endanger the ecological equilibrium and for this reason their proportion is only around 15%. On the other hand, a high carrying capacity in the Coastal Plain and the Northern Valleys (45 and 54 feed units respectively) allowed breeding cattle in moderate proportions (33% on average).

Caprine/Cattle Ratio: Conclusions

The conclusions emerge from the study of caprine/cattle ratio are:

1. Cattle bones are overrepresented in zooarchaeological assemblages;
2. A small number of cattle is adequate for maintaining dry farming and plowing, hence a high proportion of cattle does not indicate an intensification of agriculture;
3. Caprines were the primary source of meat and milk. Cattle were bred primarily for plowing practices;
4. A pattern pointing to a decline in the relative frequency of cattle that follows a north-south gradient cannot be observed;
5. Approximately 15% cattle is widespread in many Near Eastern sites in the Bronze Age and Iron Age and later periods. The pattern appears in Tel Beer-Sheba strata throughout twelve hundred years of occupation as well as in the Northern Negev and Central Hill sites;

6. The caprine/cattle ratio reflects the survival subsistence strategy. Cattle proportion was low in regions with relatively low ecological conditions (i.e. the Northern Negev and Central Hill sites), cattle proportion was moderate in regions with moderate ecological conditions (i.e. the low lowlands sites) and when conditions for cattle husbandry are optimal, cattle proportion is high (i.e. present times);
7. Cattle were essential for plowing practices yet cattle required large quantities of water and pasture. A low proportion of cattle represents the equilibrium between maintaining the survival subsistence strategy and the demand for plow beasts;
8. The survival subsistence strategy was fundamental and prevalent. Hence, low proportion of cattle is found in urban sites that were located in regions with limited water and pasture resources. The survival subsistence strategy also stands behind the absence of cattle among contemporary Bedouins;
9. The cattle proportion is relatively high in regions with a high carrying capacity for cattle (the lowlands), namely plentiful water and open grasslands.

The Survival Subsistence Strategy: Summary and Conclusions

The primary ideas of this chapter may be summarized as follows:

1. Many scholars advocate the notion that a market economy was prevalent in the Bronze and Iron Age, that surplus was produced for export, urban centers functioned as marketplaces and animal products among other agricultural crops were used as a segment of exchange systems;
2. The Western concept of the terms market economy and surplus have been projected falsely onto ancient economies. Exchange of goods and agricultural products most likely occurred in the Southern Levant; however, this should not necessarily reflect a market economy system. Furthermore. An exchange of agricultural products does not imply a specialized production or a market economy;
3. A surplus of livestock and animal products were produced, but not as a commodity designated either for 'export' or for gaining wealth. Surplus, when created, was banked for the most part to cope with downfall periods or was exchanged to maintain the limited demands of the domestic group;
4. The survival subsistence strategy stands in contrast with a market economy. The underlying principle of this strategy was to preserve subsistence resources (e.g. livestock, water, arable and pasture lands) at an optimal level (rather than maximal) in order to sustain the household requirements but not beyond that point;
5. Regulation of population size was one of the pillars of the survival

subsistence strategy and was aimed at preserving the natural resources. Population size was maintained even below carrying capacity in order to secure these resources;

6. The anthropological and archaeological literature is rich with data on the practice of agriculture in the Southern Levantine deserts for at least six millennia. A sedentary agricultural population, whether urban or rural, was engaged in animal husbandry. Hence, for the most part, pastoral-nomads in the Southern Levant were not dependent on cereal produced by sedentary sites and sedentary societies were certainly not dependent on livestock products from by pastoral-nomads;
7. The premodern and modern era is characterized by enhanced health, developed transportation infrastructure, accessible lucrative labor, industrial and urban centers that are dependent on external agricultural production, all-purpose money, strong central governments, and defined political borders. We should bear in mind that these factors did not exist in ancient times. Therefore, the analogy of contemporary economic mechanisms (e.g. sedentarization and nomadization) is most likely not applicable to those in antiquity;
8. Pastoral-nomadism was a strategic preference rather than an imposed one. It is probable that what led scholars to argue that sedentists were compelled to become nomads is the Western frame of mind that sedentism was a superior and a natural choice. Pastoral-nomadism coincides with the survival subsistence strategy. It allowed nomads to exploit effectively marginal ecological niches, avoid competition with other groups, minimize the spread of disease and evade the control of central governments;
9. An analogy was drawn between animal species occupying adjacent habitats and human 'sister-species'—the 'Homo sapiens nomadus' and the 'Homo sapiens sedentus'. If the 'nomadus' would adopt a sedentary lifestyle, or vice versa, he would be forced to go through behavioral, cultural and ideological modifications as well as adjustments in morphology and physiology. Sedentists and particularly pastoral-nomads have undergone a process of adaptation to their habitat, thus would be reluctant to relinquish it;
10. A quantitative analysis of zooarchaeological and ethnographic data from 70 sites and strata in the Southern Levant was conducted in order to test the hypothesis of the survival subsistence strategy. No regional pattern in the sheep/goat ratio was found. In 76% of 57 sites and strata, the percentage of sheep does not exceed 67%. This indicates that the caprine herd management was aimed at herd security and survivorship. Comparison between zooarchaeological data and ethnographic data from the British census shows a dramatic shift in the proportion of sheep, from approximately two thirds in the Bronze and Iron Age to one third in pre-modern times. The sheep/goat proportion represents an equilibrium

between herd security (i.e. goats) and the demand for wool (i.e. sheep). The cause for the dramatic drop off in sheep proportion in premodern times was probably the fact that wool was no longer essential for textile production. Considering the survival subsistence strategy was still maintained in premodern times, the proportion of goats increased in order to maximize herd security;

11. The comparative analysis shows that in 45 of 54 sites (83%) caprines were utilized for the whole range of products rather than for a particular product (meat, milk or wool). The analysis points to a self-sufficient economy that was prevalent in all periods, geographical regions and in both rural and urban sites. Culling of sub-adults as well as mature animals is a coherent ecological mechanism in herd management that coincides with the survival subsistence strategy and does not point to the export of market-age animals;
12. Cattle were not the primary source for meat production. A high proportion of cattle does not indicate an intensification of agriculture;
13. Cattle were essential for plowing practices yet cattle required large quantities of water and pasture. A low proportion of cattle thus represents the equilibrium between maintaining the survival subsistence strategy and the demand for plow beasts.

The Faunal Remains from Tel Beer-Sheba, Stratum II

Methods

The Recording Process

The procedure of data recording included the identification of specimens to species, skeletal element and side (left or right). Fragments of limb bones were assigned to an articular end (distal or proximal) or shaft. Some specimens that were identified to a particular skeletal element, were grouped at a later stage to a general body part category in order to allow a larger sample for analysis. For instance, all ischium, ilium and pubis fragments were grouped into one skeletal element category: the pelvis. In addition to the basic identification, other data on bone modifications were recorded. These include: 1) burn marks; 2) drilling or perforation marks (in secondary use of bone tools); 3) cut (or chopping) marks, occurring during the butchery process; 4) gnawing marks caused by rodents or carnivores; 5) fresh breaks (fractures), occurring during the archaeological excavation or later stages. Other modification marks, such as the grinding and polishing of the astragali bones, were recorded as well.

The preservation percentage for each specimen was recorded. For instance, one specimen of one-half distal humerus received NISP value of 1 and a preservation value of 50%.

Each specimen identified to a level of skeletal element and species was labeled with a consecutive identification number using a permanent marker (Meadow 1980:73). This number corresponds with the database recorded on "Microsoft Excel" and "Access" programs, which is comprised of the entire information available on the identified specimens. The identified specimens and the dataset were stored and are accessible for further study. Specimens that could not be identified to a body part were assigned to a group size (small, medium, large; Table 3.1). The 'small' class represents rodents or birds, the 'medium' class is the most common group and it represents caprines, gazelles or dogs, and the 'large' class represents cattle, donkeys or pigs.

Taxonomic identification was carried out using comparative collections located at the Institute of Archaeology at Tel Aviv University and at the Department of Evolution, Systematics and Ecology at Hebrew University, Jerusalem. Anatomical atlases were used as well (Parker *et al.* 1951; Sisson 1953; Schmid 1972; Prummel 1987a; 1987b; 1988; Helmer and Rocheteau 1994). Sheep bones were distinguished from those of goats using criteria provided by Boessneck (1969) and Prummel and Frisch (1986). Mortality profiles were generated using indices of epiphyseal fusion (Silver 1969; Bullock and Rackham 1982) and teeth eruption and wear (Payne 1973; Deniz and Payne 1982; Grant 1982; Hillson 1986). For the analysis of the latter method, a mandibula

containing a single or several teeth was treated as a single specimen.

Quantification Methods

Several quantification methods were applied in this research:

- NISP (number of identified specimens) is the most common quantification method used in zooarchaeological studies (Grayson 1984:17–34; Reitz and Wing 1999:191–202). It represents the total number of identified skeletal elements (e.g. distal tibia) and their side in a skeleton, if applicable (e.g. right or left);
- MNI (minimum number of individuals) represents a firm minimum number of animals that can be derived from a bone assemblage based on the most frequent skeletal element (and siding) per taxon (Ringrose 1993:126–7; Lyman 1994a);
- RF (relative frequency) combines components of the MNI and NISP methods. The RF value is derived by tallying the relative frequency of each primary skeletal element and dividing them by the number of categories (i.e. skeletal elements) contributing to the count (Hesse and Wapnish 1985:115–16);
- MAU (minimum animal units) values are derived from NISP values. It is calculated by dividing the observed bone count for a given identification unit by the number of bones in the anatomy of a complete animal for that unit (Binford 1978:70);
- %MAU standardize the MAU values (Binford 1978:69–72; Lyman 1994a:57). It is done by dividing all observed MAU values by the greatest observed MAU values and multiplying by 100 to scale the values between 0 and 100 (e.g. [Table 5.4](#), column 2, 4);
- MNE (minimum number of elements), denotes the minimum number of particular skeletal element per taxon. It is derived by tallying the percentage of preservation (see above) for each measured portion of a skeletal element and then dividing it by 100 (Klein and Cruz-Urbe 1984; Bunn and Kroll 1986; Marean 1991; Reitz and Wing 1999). For instance, four specimens of distal femur with a percentage of preservation of 30%, 50%, 70% and 80% sums to MNE value of 2.3 (230/100) and their NISP value is 4.

Results and discussion

Over 10,000 bones originating in 683 bone baskets and 217 loci from Stratum II were examined. Approximately 40% of the bones were identified to a level of skeletal element and species and the remaining assemblage was identified to a level of size class ([Table 3.1](#)). Similar ratio between the identified and partially

identified bones is reported by Zeder (1991:103–106) who examined 100,000 bones from Tel Malayan in central Iran.

Caprines (*Ovis aries* and *Capra hircus*) and cattle (*Bos taurus*) predominate the assemblage with 95.5% of the finds, a common phenomenon in sites dating to historical periods. The caprine/cattle ratio was calculated using NISP, MNI and RF count methods. All three methods obtained similar results; caprines comprised approximately 85% of the caprine and cattle bones (Table 2.4).

The Primary Species

Caprines. The majority of the faunal remains recovered from Stratum II consist of caprines with NISP value of 3512 and MNI value of 66. MNI was determined by the most frequent skeletal element, the right distal humerus. Of the total caprine bones, 568 (56%) were identified as a domestic sheep (*Ovis aries*) and 445 specimens were identified as domestic goats (*Capra hircus*). Some scholars distinguish sheep from goats based on the distal metapodial bones only (Hellwing 1986; Davis 1988). Using only distal metapodia reduces the sample for analysis and may blemish its reliability.

<i>Species</i>	MNI	NISP	
	#	#	%
Sheep (<i>Ovis aries</i>)		568	
Goat (<i>Capra hircus</i>)		445	
Caprines (grand total)	66	3512	82.3
Cattle (<i>Bos taurus</i>)	12	568	13.3
Birds (<i>Aves spp.</i>)	(-)	84	2
Camel (<i>Camelus dromedarius</i>)	2	14	
Gazelle (<i>Gazella doracas</i>)	1	10	
Dog (<i>Canis familiaris</i>)	1	7	
Pig (<i>Sus scrofa</i>)	1	6	
Rat (<i>Rattus rattus</i>)	1	6	
Donkey (<i>Equus asinus</i>)	1	4	2.5
Fallow Deer (<i>Dama mesopotamica</i>)	1	2	
Weasel (<i>Mustela nivalis</i>)	1	2	
Mouse (<i>Mus musculus</i>)	1	2	
Turtle (<i>Testudo graeca</i>)	1	2	
Gerbil (<i>Gerbillinae sp.</i>)	1	1	
Fish	(-)	7	
Total NISP	90	4274	100
Large mammal		5897	
Medium mammal		298	
Small Animal		65	
Grand total		10534	

Table 3.1 Number of identified specimens per taxon and size group category.

While the total sample of over 1000 specimens points to a sheep proportion of 56%, a sample of 90 distal metapodia, shows a sheep proportion of 51%. Prima facie, the results support the use of smaller samples, though additional studies of metapodial bones versus the entire sample should be carried out in order to confirm this observation.

Mortality profiles of the caprine herd were generated based on epiphyseal fusion and teeth eruption and wear. Fusion plates were identified on 857 specimens of caprines. The specimens were grouped in four age groups; bones that fuse approximately at the age of 6–10 months, 13–16 months, 18–28 months and 30–42 months (Table 3.2, Figure 3.1). Table 3.2 shows that a relatively small percentage (15–16%) of the bones were found unfused under the age of 16 months. This means that approximately 15% of the animals in this age group died before the age of 16 months. These numbers coincide with data from ethnographic and ancient text sources on mortality rates of young caprines. Cribb, who carried out a study of caprine herds in contemporary southern Turkey, notes that 15% of the newborns died due to natural causes in their first year of life (Cribb 1984:167, see also Russell 1988:63; Borowski 1998:68–70). Abu Rabia (1994:107–14) provides us with similar mortality rates regarding the Bedouin herds in the Negev. Ellison (1978:93), who studied Old Babylonian texts, notes a 20% mortality rate of caprines. Thus, the 15% mortality of lambs and kids at the age of 16 months and younger, should be attributed, for the most part, to death by natural causes rather than a specialization in meat production (see Chapter 2 for discussion on this topic).

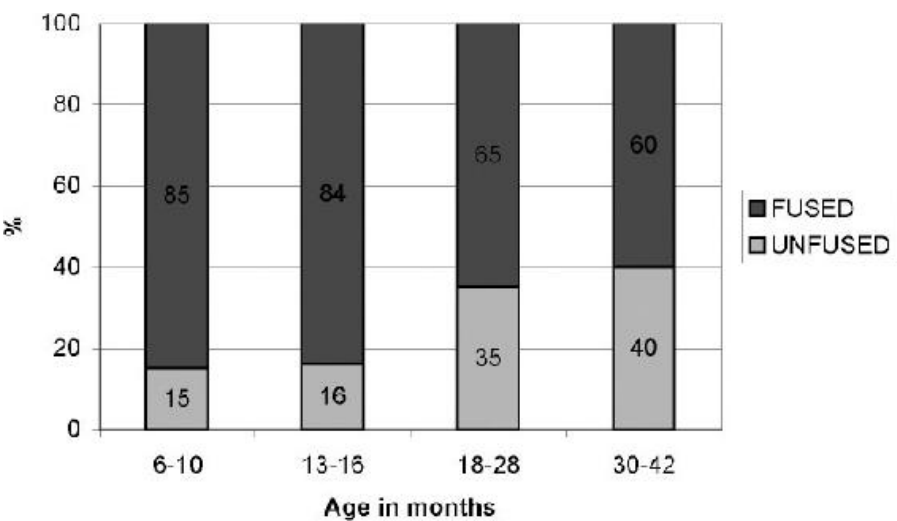


Figure 3.1 Caprine mortality profile, based on epiphyseal fusion.

At the sub-adult age group (18–28 months), approximately 35% of the bones were found unfused. As discussed in Chapter 2, it is common that most of the males and a small number of females of this age are culled when they reach an optimal size in order to regulate herd size and free pasture and water for the reproductive milch ewes. The proportion of sub-adults in contemporary caprine herds in the Central Hill country in Israel was approximately 35–40% (Sasson 1998; 2006). The similitude between the ethnographic data and the zooarchaeological data is striking.

At the adult age group (30–42 months), 40% of the bones were found unfused and this means that a relatively large number of animals died at an age of approximately three years or older. Culling livestock at this age is also an integral component of herd management. Adult ewes and rams are culled when they reach the end of their productive life (i.e., the ability to adequately reproduce and provide milk), around the age of 5–6 years (Cribb 1991:29; Sasson 2006:36, and see Chapter 2).

In sum, the mortality profile of caprine herds, as it appears in the bone assemblage of Stratum II, is a result of death by natural causes as well as a coherent ecological mechanism of herd management aimed at the regulation of herd size and freeing pasturage and water for ewes (Sasson 2008).

The disparity between the mortality profiles of sheep and goats is striking. Of the 857 caprine specimens with fusion plates, 269 were identified as either sheep or goats (Table 3.3). Figure 3.2 shows that in the first three age groups (6–10, 13–16, 18–28 months), the proportions of unfused bones of goats range from 23 to 29% and are two to three times larger than that of sheep. Conversely, the proportion of sheep in the adult age group is 43% and almost three times larger than that of goats. As discussed in Chapter 2, wool was an essential raw material for textile products (McCorriston 1997; King and Stager 2001:147). The large percentage of adult sheep in Stratum II and clearly indicates that sheep were kept alive to an older age in order to increase wool production most likely for self-use.

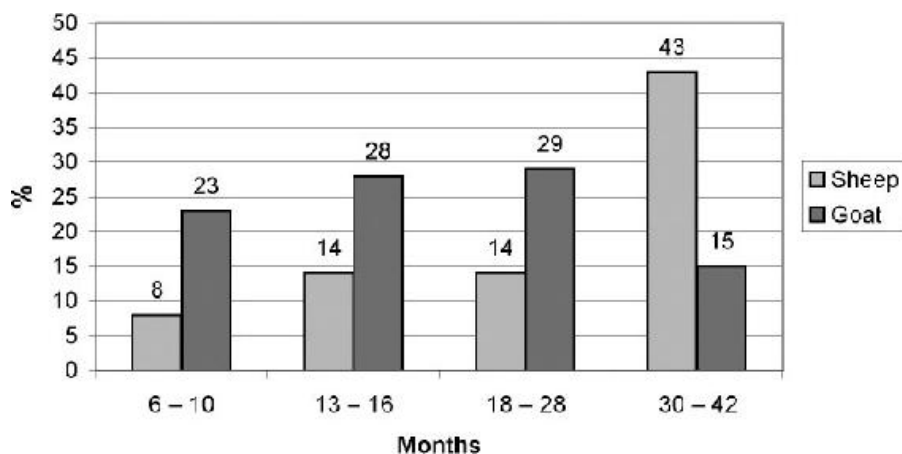


Figure 3.2 Mortality profile of sheep versus goats based on epiphyseal fusion.

<i>Age (in months) and Skeletal Element</i>	<i>Unfused</i>	<i>Fused</i>	<i>Total</i>	<i>Unfused in %</i>
6 - 10				
Scapula	15	54	69	22
Distal Humerus	15	115	130	12
Proximal Radius	8	44	52	15
Acetabulum	0	4	4	0
Total/Average	38	217	255	15
13-16				
Phalanx I	27	103	130	21
Phalanx II	3	49	52	6
Total/Average	30	152	182	16
18 - 28				
Metacarpal	23	46	69	33
Metatarsal	12	18	30	40
Metapod	18	3	21	86
Distal Tibia	14	56	70	20
Total/Average	67	123	190	35
30 - 42				
Calcaneus	18	43	61	30
Ulna	8	24	32	25
Proximal Femur	17	19	36	47
Distal Femur	16	14	30	53
Proximal Humerus	9	6	15	60
Distal Radius	7	18	25	28
Proximal Tibia	17	14	31	55
Total/Average	92	138	230	40

Table 3.2 Caprine mortality profile, based on epiphyseal fusion.

<i>Age in Months</i>	<i>Sheep</i>		<i>Goat</i>	
	<i>Specimens examined</i>	<i>Unfused in %</i>	<i>Specimens examined</i>	<i>Unfused in %</i>
6-10	73	8	33	23
13-16	18	14	12	28
18-28	30	14	22	29
30-42	35	43	46	15

Table 3.3 Mortality of sheep versus goats based on epiphyseal fusion.

A study of 218 mandibles and isolated teeth provides us with an additional mortality profile. Figure 3.2 presents the data according to stages of teeth eruption and wear as suggested by Payne (1973). The small number of

specimens in the first three stages is probably related to the low survival rates of mandibles of young caprines due to taphonomic agents (Binford and Bertram 1977:105–109; Payne and Munson 1985). In order to refine the dental data and compare them with the epiphysial fusion results, Payne's stages were grouped into three age classes: 0–12 months; 12–36 months; and 36 months or older (Figure 3.4). Figure 3.4 reveals a remarkable parity with the fusion mortality profile: 18% of the caprines were culled young (under the age of 1 year); 45% were culled at sub-adult age (1–3 years); and 37% as adults (3 years or older).

Cattle. Cattle is represented in 568 identified specimens with MNI value of 12. MNI was determined by the most frequent skeletal element, left distal humerus.

Cattle age at death was derived from 198 bones with fusion plates. In order to create an adequate sample for analysis, the specimens were grouped into two age classes: 7–18 months and 24–42 months (Table 3.4, Figure 3.5). Only 9% of the bones in the first group and 18% in the second group were found unfused. This clearly indicates that the cattle of Tel Beer-Sheba died at an older age. Cattle were normally kept to an older age in order to be used for draught and plowing (Sherratt 1981; Sasson 2005a, see Chapter 2 for discussion of this topic). An additional indication for the use of cattle for plowing is the iron plowshare weighing approximately 3 kg found at building 76 in Tel Beer-Sheba (Beit Arie 1973a). Cattle bones were inspected for pathologies occurring as a result of hard labor (Bartosiewicz, *et al.* 1997; Baker and Brothwell 1980:114–122). Only minor pathologies were found. The lack of pathologies does not necessarily negate the use of cattle for plowing or draught. According to Avitsur (1965:56–74), various plows were used in varying conditions of soil, climate and farming in Israel. The light ard or the simple sole ard was used in the loess soils of the Negev. It is most likely, that plows used in the ancient Negev were relatively light and that the Beer-Sheba cattle did not suffer from stress-induced pathologies.

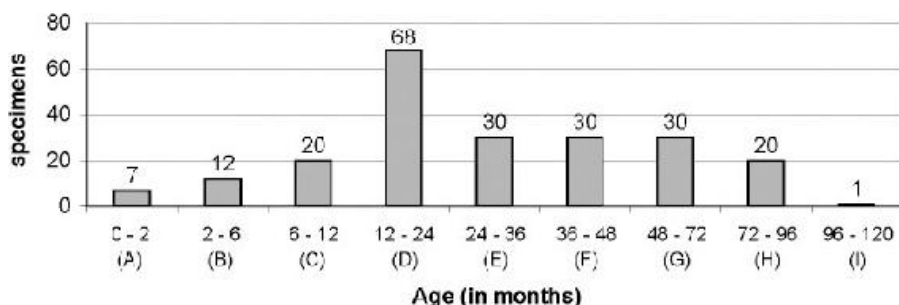


Figure 3.3 Age at death of caprines based on stages of dental eruption and wear.

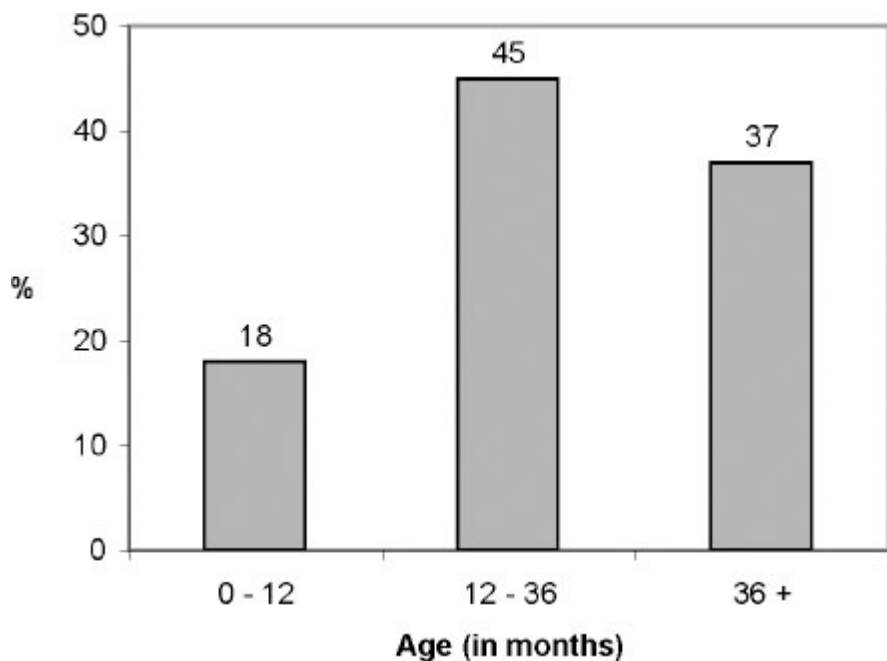


Figure 3.4 Caprine mortality profile based on dental data.

Camel. Fourteen camel bones were identified in ten loci of Stratum II. The skeletal elements comprises phalanx I and II, metatarsal, carpal and teeth. The MNI value for camel is two based on two lower right second molars. The geographic context suggests that the camels from Tel Beer-Sheba are the dromedaries breed (*Camelus dromedarius*). A distal metatarsal partially fused (Silver 1969) and two unworn molars (Payne 1973) indicate that the camels died at a relatively young age, considering the fact that a camel's lifespan is over 40 years (Clutton-Brock 1987:124–5).

Camel bones in the Iron Age II were found in small numbers at Tel Hesban (LaBianca 1990), Tel Lachish (Croft 2004) and Tel Michal (Hellwing and Feig 1989) and in relatively large numbers (n=48) in Tel Jemmeh (Wapnish and Hesse 1988).

According to Jasmin (2005:148–9), camels played a major role in the emergence of copper and incense at the end of the second millennium BCE. Singer-Avitz (1999:54–60, see also Bienkowski and van der Steen 2001:37) argues that Tel Beer-Sheba functioned as a gateway community providing services to camel caravans passing through the site. We should note that faunal remains found in archaeology belong, for the most part, to animals used for consumption (Renfrew and Bahn 1991:54). Therefore, the dearth of their remains should not be interpreted as reflecting their rarity. We may deduce on the use of camels from the relative frequency of cattle. As mentioned before, cattle were the primary plow beast in the Iron Age. In later periods they were displaced by camels (see also Sasson 2005a). For this reason, cattle are absent

among contemporary Bedouins in the Negev while camels are commonly used by these groups. We may presume that if the use of camels for plowing and transportation was widespread in the Iron Age, cattle remains would be virtually absent from the Northern Negev sites. This hypothesis though, requires further investigation.

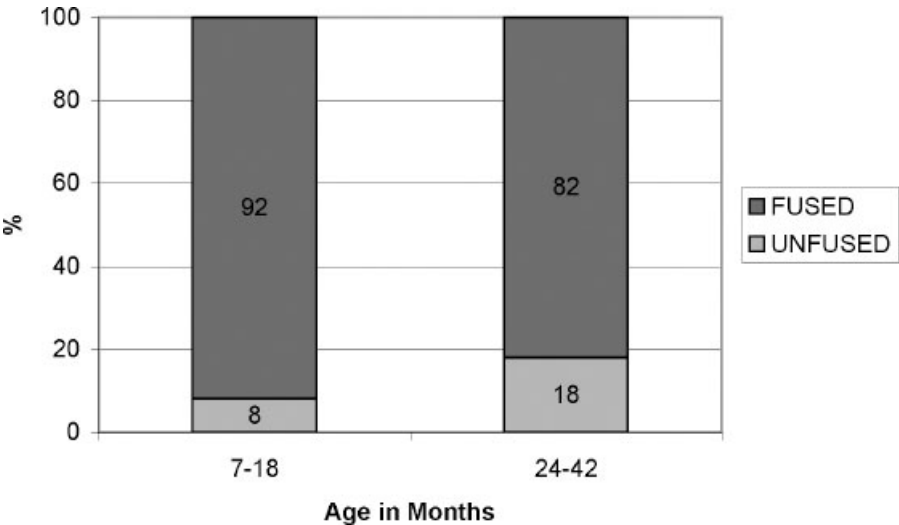


Figure 3.5 Cattle mortality profile, based on epiphyseal fusion.

<i>Age (in Months) and Skeletal Element</i>	<i>Unfused</i>	<i>Fused</i>	<i>Total</i>	<i>Unfused in %</i>
7 - 18				
Distal Humerus	2	15	17	12
Scapula	2	14	16	13
Proximal Radius	1	10	11	9
Phalanx I	2	28	30	7
Phalanx II	1	23	24	4
Total	8	90	98	8
24 - 42				
Metapod	5	28	33	15
Distal Radius	1	3	4	25
Distal Tibia	3	13	16	19
Proximal Tibia	1	4	5	20
Calcaneus	2	14	16	13
Femur	5	17	22	23
Proximal Humerus	1	3	4	25
Total	18	82	100	18

Table 3.4 Cattle mortality profile, based on epiphysal fusion.

Donkey. Four specimens of domestic donkey (*Equus assinus*) were discovered in Stratum II. They are originated in three loci and comprise 2 carpal bones and 2 lower molars (M/1 and M/2) generating an MNI value of 1. The molar teeth were identified as domestic donkey rather than horse based of criteria listed by Davis (1980). Donkey bones in the Iron Age II, were also found at Tel Hesban (LaBianca 1990), Pella (Kohler-Rollefson 1992a), Tel Lachish (Croft 2004), Tel Jemmeh (Wapnish and Hesse 1988), and the site of the City of David (Horwitz 1996b).

Dog. Seven specimens of dog (*Canis familiaris*) were identified. They originated in seven loci and include two humeri, femur, astragalus, metatarsal and two lumbar vertebrae, generating an MNI value of 1. Dog bones, in the Iron Age II, were also found at Tel Lachish (Croft 2004), Tel Dan (Wapnish and Hesse 1991) and Tel Masos (Tchernov and Drori 1983).

Pig. Nine specimens of pig (*Sus scrofa*) were identified. They originated in three loci and include two first phalanx bones, scapula, metatarsal and two fragments of mandibula, generating an MNI value of 1. The phalanx bones were found unfused indicating they originated in a two year old individual (Silver 1969). Pig bones, in the Iron Age II, were also found at Tel Hesban

(LaBianca 1990), Pella (Kohler-Rollefson 1992a), Tel Lachish (Croft 2004), Tel Jemmeh (Wapnish and Hesse 1988), Tel Miqne (Lev-Tov 2000), Tel Dan (Wapnish and Hesse 1991) and Tel Qiri (Davis 1987b).

It is evident that pigs were not used for consumption at Stratum II. As discussed above, animals that were exploited for food, would leave a profound mark on the zooarchaeological record. There is an ongoing debate as to whether the taboo on pigs originated for practical-ecological reasons or cultural-ideological (cf. Harris 1974; Diener 1978; Hesse 1990; Zeder 1996; Raban-Gerstel, et al. 2008). It is possible that pigs were avoided in Iron Age Tel Beer-Sheba due to religious taboo. Nonetheless, I advocate the notion that the primary reason for the taboo on pigs, in many regions of the Southern Levant, was ecological. Pork would have made a considerable contribution to the human diet (Sasson 1998). However, caprines and cattle provided adequate animal-derived nutrients as well as wool, hair and hides (Sasson 2006). Bearing in mind that ancient populations strove to minimize risks in order to maintain a long-term survival, pig husbandry would have stood in contrast with this strategy. Pigs need to be watered daily and do not cope well with temperature extremes (Harris 1974:40–42; Van Loon 1978). Furthermore, a large part of the Southern Levantine population engaged in some mode of mobility, which made pig husbandry impractical. Gradually, the ecological practice evolved into a cultural-ideological belief.

Gazelle. Ten specimens of gazelle were identified. They originated in eight loci and include two first phalanx bones, a scapula, a metatarsal, a horncore and five vertebrae (thoracic and lumbar), generating an MNI value of one. The geographic context suggests that the specimens belong to the mountain gazelle (*Gazella gazella*). Gazelle bones, in the Iron Age II, were also found at Pella (Kohler-Rollefson 1992a), Tel Lachish (Croft 2004), Tel Jemmeh (Wapnish and Hesse 1988), Tel Miqne (Lev-Tov 2000), Tel Dan (Wapnish and Hesse 1991) and Tel Qiri (Davis 1987b). Evidently, gazelles were used for consumption before the domestication of caprines and cattle and they predominate in faunal assemblages from prehistoric sites (Rabinovich *et al.* 1996; Bar-Oz *et al.* 2004; Munro and Bar-Oz 2005). Their small number clearly indicates that gazelles were not part of the daily consumption in Stratum II.

Rat. Six specimens of what is most likely the black rat (*Rattus rattus*) were identified. They originated in three loci and include a pelvis, a tibia, a cranial bone and three femora. The MNI is two, based on the femur bones. One femur was found unfused at the proximal and distal ends, which indicates that it belonged to a young individual.

Birds. Eighty-four specimens of birds originating in 39 loci were identified in Stratum II. The bird bones require further study. Forty-three specimens were identified to perching bird size (*Passeriformes*); nine to Falcon size (*Falconiformes*); six to goose size (*Anseriformes*); 13 to the dove order

(*Columbiformes*) and 13 as partridge (*Alectoris sp.*).

Perforated Bones

The faunal remains from Stratum II included 10 perforated bones of caprines and one of cattle. Two caprine metacarpals and two metatarsals were found with a fairly symmetric round hole, 60 mm in diameter, on the proximal articular surface (Figure 3.6:1). The perforation of metapodial bones, reported in the zooarchaeological literature, is normally associated with marrow extraction. The hole not only allows extraction of bone marrow but also preserves the usefully shaped metapodials for craftwork (Bigelow 1995; Edvardsson *et al.* 2004; O'Connor 2000:47). Since no taphonomical evidence for marrow extraction was found in Tel Beer-Sheba, the metapodial bones were most likely used as handles for a blade or awl, which was attached to the man-made hole (MacGregor 1985:175). Evidence supporting this idea was found at the Chalcolithic site of Shiqmim, where a copper awl mounted in a handle made of sheep or goat metapodial is reported by Levy and Alon (1987:689, 717). According to Grigson (1987:227) the awl was used for piercing hides and beads. Two first phalanx bones were found drilled on their proximal surface which suggest they were used as small awls.

A rectangular hole, 90 × 50 mm in dimension, was found in two tibiae (Figure 3.6: 4, 5), either on the cranial or caudal shaft and adjacent to the distal articular surface. A similar perforation was found in two caprine radii (Figure 3.6: 2) and cattle calcaneus (Figure 3.6: 3), adjacent to the proximal articulation surface (Figure 3.7). Their large circumference makes it less likely they were a result of dog's bite. The parallel location and dimension of the rectangular holes may indicate that the bones were used as tools. However, the purpose of these tools remains unclear.

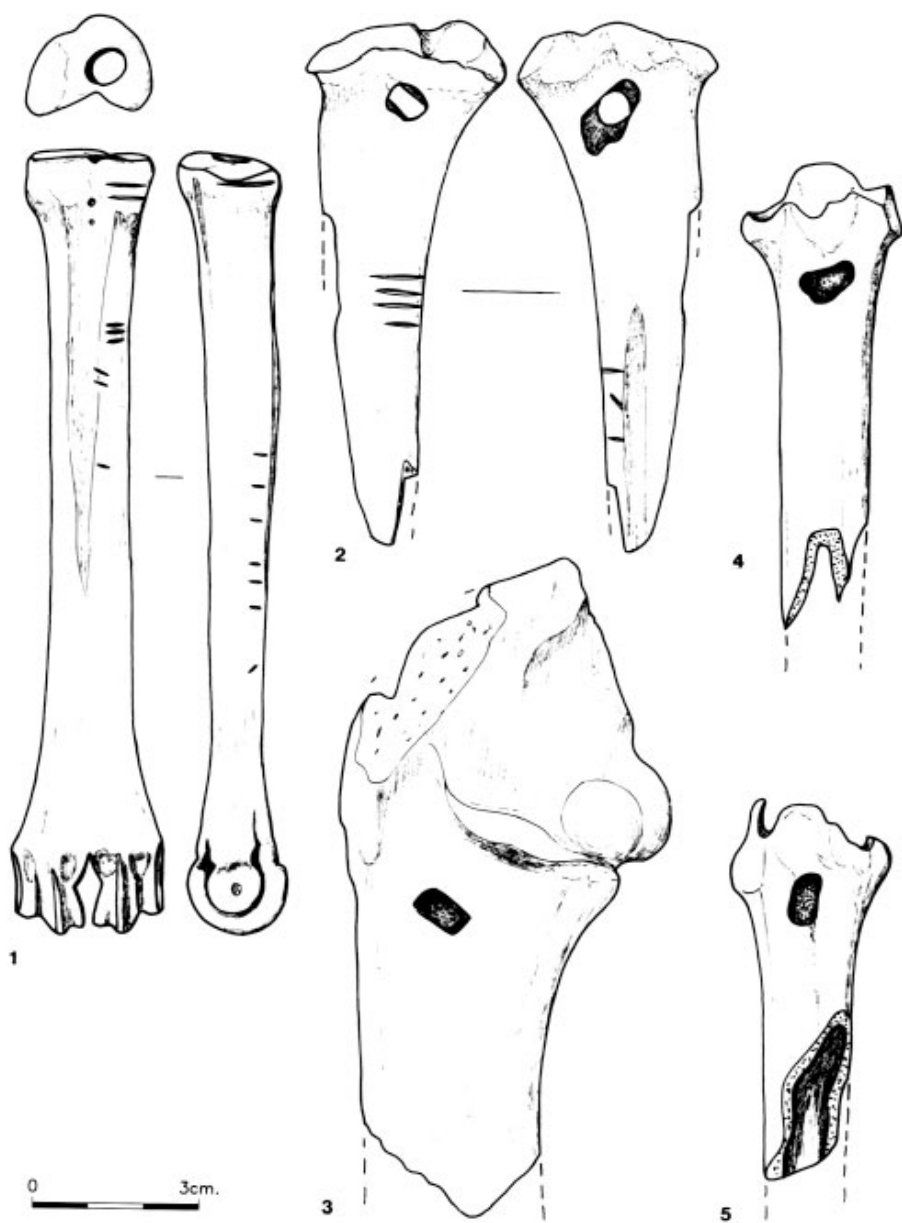


Figure 3.6 Perforated bones of caprines and cattle (1- metacarpal, 2- radius, 3- cattle calcaneum, 4 and 5- tibiae).



Figure 3.7 Perforated bones of caprines and cattle.

A Spatial Perspective: Controlling Space and the Zooarchaeological Record—a GIS Spatial Analysis of Faunal Remains in Stratum II, Tel Beer-Sheba

Geographic information systems (GIS) offer archaeologists an exciting and powerful research tool destined to have as profound an effect on the field of archaeology as did the introduction of carbon dating in 1950s. Archaeological data is spatial and temporal in nature and therefore especially suited the basic principals driving the development and use of GIS (Wescott and Brandon 2000:1).

There is no doubt GIS (Geographic information system) is a powerful tool, as Wescott and Brandon state, in the introduction to their book on GIS and archaeology. GIS is frequently employed in archaeological studies. However, most studies focus on landscape archaeology and very few focus on intra-site spatial analysis. Moreover, the GIS is seldom employed in zooarchaeological studies (see, for example, Herrmann 2002). This chapter demonstrates the spatial perspective in zooarchaeology and principally, the importance of GIS for intra-site analysis.

GIS is a computerized application working with digitized maps. For the most part, GIS does not address issues that maps or plans drawn on paper, transparency sheets and colored markers cannot address. The paramount advantage of GIS over old spatial analysis techniques is that when a computerized geodatabase is created, numerous spatial queries can be addressed in a relatively short time. GIS can handle without difficulty a vast amount of data, add and remove layers of information and address multifaceted queries. The same queries could be addressed using non-computerized methods yet it is significantly time consuming. In addition, with a GIS platform, the researcher is granted an enhanced display and a real-time observation of the finds (Harris 2002:132; Nardini and Salvadori 2003:128; Christopherson 2003).

Stratum II at Tel Beer-Sheba represents an ideal site for spatial analysis. It was the final phase of the urban occupation and following its destruction, except for a short occupational phase (Stratum I), Tel Beer-Sheba was not reoccupied in the Iron Age. Two-thirds of Stratum II have been excavated, revealing a well-planned town extending over 11 dunam and containing 75 houses, radial streets, storage houses, a water system and a casement city wall (Herzog 1992; 1993). The clear outline of Stratum II allows us to identify most architectural units such as rooms, yards and streets. In addition, numerous ceramic vessels and other artifacts, many of them complete, were unearthed at Stratum II. In sum, the clear architectural outline, the abundance of archaeological and zooarchaeological finds make Stratum II an excellent model for spatial analysis.

Methods and Materials

Geographic information systems work with two fundamentally different types of geographic models—the ‘vector’ model and the ‘raster’ model. The study of Stratum II is vector-based GIS, which is a data structure used to store spatial data. Vector data is comprised of points, lines and/or polygons, defined by beginning and end points which meet at nodes. The locations of these nodes and the topological structure are usually stored explicitly (Wheatley and Gillings 2002:32–5).

In order to upload the zooarchaeological database of Stratum II onto a GIS platform, the following procedure was carried out: the plan of Stratum II was digitized using AutoCAD software. The digitized plan was uploaded on a GIS platform using the MapInfo application. The zooarchaeological data was recorded onto Microsoft Excel software (see [Chapter 3](#)) and later transferred to Microsoft Access software. The database includes all the information available for each locus, including general archaeological data such as the opening and closing dates of a locus and the locus elevations. The database also includes all the archaeological finds that were discovered in each locus such as ceramics, artifacts and the entire zooarchaeological information (see [Chapter 3](#)). The database was linked to the digitized plan of Stratum II using Blue Marble GeoObject and Visual Basic applications. Each locus is represented by a blue dot in the digitized plan of Stratum II (see [Figure 4.10](#) for example). The location of the dot stands for the general location of a locus. Each identified bone is displayed by a symbol, a pound symbol in most cases. The symbols (i.e. bones) are displayed in concentric circles around the blue dots, which represent the loci location. A greater number of circles displayed, indicates a greater number of bones discovered at the locus.

The faunal data from selected loci that consist of a large number of bones (e.g. street 664, room 1789, storeroom 1007) were compared statistically (chi-square test) with the entire faunal data of Stratum II. The test was carried out in order to address the question: is there a significant difference between the faunal data of one or several loci and the general faunal data of Stratum II?

The Nature of Faunal Remains on Archaeological Sites

Finally there is the phase of disposal, the true arena of archaeological practice. Here we hit the realm of formation processes ... after all, the disposal of rubbish is socially and culturally defined (Van der Veen 2003:417).

Before presenting the results of the spatial analysis, it is important to briefly discuss the nature of animal bones as an archaeological find. LaBianca (1995e:42), states that, of an initial live faunal assemblage, only 2% are anticipated to be preserved archaeologically as bone. Meadow (1980:66) stresses the fact that life assemblages are rarely represented in death

assemblages. In another paper, he discussed this issue and concluded that 'archaeological bone can be expected only to reflect and not to represent practices of animal selection, food preparation, and consumption' (Meadow 1978:15). Schiffer (1976:14–15), in a pioneering theoretical study of behavioral archaeology, characterized the archaeological evidence to C-transforms (cultural formation process) and N-transforms (noncultural formation process). The first are items discarded during the normal operation of a cultural system and the latter is evidence shaped and altered by noncultural processes, such as wind, water, rodent activity and chemical action. The taphonomic study carried out in Tel Beer-Sheba ([Chapter 5](#)) demonstrates that multiple agents may alter the bone assemblage, its preservation as well as its spatial position. These agents include the consumption of animals by humans, scavenging dogs, fluvial transport processes, post-depositional processes, the archaeological dig and more.

It should be admitted, as poetically described by Van der Veen (2003:417), that zooarchaeology focuses, for the most part, on the study of unwanted refuse of human consumption (Meadow 1978:15; Renfrew and Bahn 1991:259; O'Connor 2003:78). Schiffer (1972:161) has suggested that it is important to distinguish between primary and secondary refuse. Both refer to elements which have been discarded, but in the case of secondary refuse the location of the final discard is not the same as the location of use. Primary refuse is material discarded at its location of use (see also Meadow 1980:66).

Binford and Bertram (1977:77–8) and Hodder (1986:103–17) have noted that we ought to be cautious when interpreting static relics. Hodder (1986:103–17) demonstrates this in an ethnographic study carried out at Lake Baringo, Kenya. He showed that only one of the tribes (the Ilchamus), in the Lake Baringo region, decorated their calabashes by incising them with rectangular designs. One approach for addressing this cultural behavior could be that compared to other tribes in this region, the Ilchamus had a greater social complexity and the decorated calabashes indicate the need for a more symbolic display. Hodder (1986:106) explains that we 'impose on the Ilchamus our own Western concepts, explain their culture in our terms without trying to understand them, to let them teach us'. Hodder's study shows that the calabashes were not related to social complexity and they were decorated by the women as a potential item for sale to tourists.

Animal bones are static relics. They should be interpreted with caution but their contribution to the understanding of ancient economies or social complexity certainly cannot be avoided. Van der Veen (2003:405) states that 'ethnographic research has revealed that an emphasis on quantity of food and elaboration of common staples is found mostly in societies without strong social stratification, while an emphasis on quality and style is characteristic of societies with institutionalized forms of social ranking' (see also Ervynck *et al.* 2003:432). Marshall (1994) studied the Okiek hunter-gatherers in Kenya. She concluded that meat-sharing (i.e. skeletal element representation in various

housholds) among the Okiek households is consistent, patterned and strongly correlated to individual hunting success and social relationship (for another example from the Congo Basin see Schmitt and Lupo 2008). Emery (2003) has carried out a zooarchaeological research of the Maya culture in Guatemala. She found a correlation between the distribution of exotic and ritual species to hierarchically ranked residences. Miller and Burger (1995) studied the faunal remains recovered from the excavations of residential contexts at Chavin de Huantar in Peru. They concluded that socioeconomic stratification at the site is reflected in differential access of the community elite to tender meat from younger animals. According to Ervynck *et al.* (2003:437), bones of brown bears in medieval Flemish castle sites can be identified as the remains of a luxury food only because they are always present, be it in low numbers, in castle sites, while they are absent from contemporaneous rural or ecclesiastical settlements. As discussed in [Chapter 2](#), models of food consumption show that faunal assemblages in sites which were provisioned with animal products from outside sources, would comprise a limited range of species, ages and skeletal elements (Wapnish and Hesse 1988:83–5; Zeder 1984; 1988; 1991:33–44; Crabtree 1990:164; 1996; LaBianca 1995a:61; Landon 1997:55–6; Stokes 2000:151).

The above studies clearly demonstrate that social complexity can be reflected in the faunal data. Tel Beer-Sheba, a well-planned urban site, with a visible architectural outline, begs for a spatial analysis of the zooarchaeological finds to address questions regarding social status, taphonomic issues and the diet of its inhabitants (Sasson 2005b; Zeder 2006:141).

Results and discussion

Spatial Distribution in Interior and Exterior Loci

As mentioned above, Stratum II has a clear architectural outline, which is rare in Bronze and Iron Age sites. This allowed us to distinguish between yards or streets (open areas) and rooms or buildings (roofed areas). Ethnographic studies show that bone refuse was dumped in yards and open areas for consumption by dogs (Binford and Bertram 1977:78–84; Kent 1981; LaBianca 1995b:27–9; Marshall 1994:67–8; Binford 1981:193; Walters 1984; Ochsenschlager 2004a:201; Spennemann 1990). We may therefore predict that a large proportion of the animal bones of Stratum II would be found in open areas, such as yards and streets. The spatial distribution of 3,652 identified specimens that were discovered either indoors or outdoors was studied ([Table 4.1](#)). At first glance, the results are surprising: 65% of the specimens (n=2386) were found indoors, in rooms, cellars, staircases or gate rooms. Only 35% of the specimens were found in loci of open areas such as yards, pits or streets. Herzog (1992), notes that Stratum II comprised of 92% roofed areas. The chi-square test shows that the indoor area contains less than expected bones

considering its relative size ($\chi^2 = 3528.3$, $df = 1$, $p < 0.0001$). Prima facie, the large roofed area is the reason for the high proportion of bones found there. In some cases, a large number of bones could be found in roofed areas such as in room 1789 ($n=219$) and building 855 (Figure 4.1). A total of 450 bones were found in the cellar house rooms. Herzog (pers. comm.) noted that the mud brick material in Stratum II was examined and did not contain animal bones. Thus, the indoor accumulation of bones was not due to the collapse of mud bricks into the enclosed area.

Three possible explanations for the abundance of animal bones in roofed areas may be considered. Schiffer (1983:692) asserted that in sedentary settlements, especially those occupied in excess of several decades, abandoned structures are often used as receptacles for secondary refuse. We may assume that the accumulation of bones in some of the buildings indicates they were not in use or were abandoned during the occupation of Stratum II. The poor ceramic finds in locus 1789 may support the hypothesis that it was abandoned. However, building 855, where 111 animal bones were found, was rich in ceramic vessels (Singer-Avitz 1999:169–70) indicating that it was occupied and active. The contrasting evidence weakens the hypothesis of abandoned buildings though it does not refute it.

The second possible explanation may be rooted in different cultural behaviors. While contemporary ethnographic sources show that animal bones were thrown to the dogs, it is possible that in antiquity, the bones were kept indoors for reasons we cannot recognize yet. This idea may be demonstrated by the fact that millions of people in the third world use an open fire for cooking indoors (Bruce *et al.* 2002). Daviau (1993:449–50) who studied the domestic activity in Bronze Age houses in Israel provides us with a similar observation, asserting that most cooking ovens were surprisingly found indoors rather than in yards. An indoor open fire causes respiratory problems for children and adults, yet it is still used these days. Meadow (1992:262) asserts that bones found on ancient floors did not originate in these floors. In other words, Meadow opposes the idea that people in antiquity dumped animal bones inside their houses. Nevertheless, we should not avoid the possibility that cultural practices unknown to archaeology might have led people to keep bone refuse within structures rather than discard them outdoors. This hypothesis is weakened by the fact that accumulations of bones were found in three open areas defined as streets: 350 bones were found in locus 1200; 58 in locus 38 (west to the cellar house), and 380 bones in locus 664 (the northern quarter). This evidence may indicate a cultural practice of disposal of bone refuse in open areas, as portrayed in the ethnographic studies. However, it does not necessarily negate a cultural practice of keeping bone refuse indoors.

The third explanation for the abundance of bones indoors may be related to taphonomic agents. Meadow (1978:18–20) has studied the relative frequency of caprine and pig bones in the exterior and interior loci at the site of Hajji Firuz,

Iran. He found a larger percentage of caprine bones in the interior loci and related it to their relative protection from weathering and dogs. The taphonomic study of faunal remains of Stratum II ([Chapter 5](#)) clearly points to density-mediated attrition of skeletal elements, namely higher preservation rates of dense bones. Schiffer (1983:692) also noted that bones deposited in roofed structures are generally not weathered, whereas those in extramural areas, deteriorate. In other words, the differential preservation conditions of bones in interior and exterior loci, altered the original bone deposition and originally, larger quantities of bones were dumped in open areas but were not preserved as well as those in the interior loci.

In sum, three possible causes for the significantly high frequency of bones in roofed structures were discussed here: (1) bone refuse was disposed of in abandoned buildings; (2) as a result of cultural practice, some of the animal bones were kept indoors; (3) the preservation rates of indoor bones are higher than the outdoors bones. It is also possible that a combination of all three factors played a role in the accumulation of animal bones in interior loci.

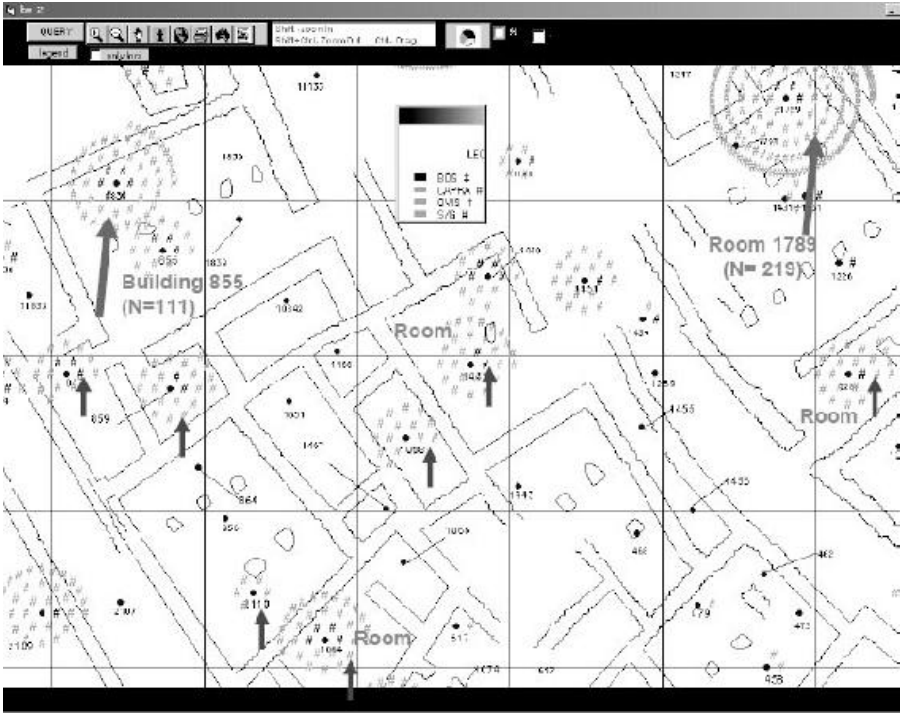


Figure 4.1 Spatial distribution of bones in roofed structures.

<i>Interior loci</i>		<i>Exterior loci</i>	
<i>Locus type</i>	<i>Bones</i>	<i>Locus type</i>	<i>Bones</i>
CITY WALL	73	COURTYARD	121
CELLAR	225	STREET	1000
CASEMATE	48	DRAIN	42
FLOOR	7	GATE	8
GATE ROOM	25	PIT	48
HALL	18	POOL	30
ROOM	1837	WATER CHANNEL	17
STAIRCASE	57		
STOREHOUSE	95		
KITCHEN	1		
Total	2386 (65%)	Total	1266 (35%)

Table 4.1 The distribution of faunal remains in interior and exterior loci.

Rare Species Distribution

The faunal remains of Stratum II are dominated by caprine and cattle bones. The remaining finds (4.5%) comprise avian species, camel, donkey, dog, rodents and fish (see [Chapter 3](#)). The spatial distribution of 135 specimens of rare species was studied. Three concentrations of bones were observed, one at the storehouses (for description of the storehouse see Herzog 1973) and two at the cellars house ([Figure 4.2](#)). The faunal remains in locus 1007, the northern hall of the storehouses, are diverse and include three bones of fish, three of birds, two of camel, one of dog and one of donkey. Although the number of specimens is small, the diversity of species is striking. The Finds in Hall (locus) 1007 also include over 130 caprine and cattle bones as well as many complete ceramic vessels, such as 15 bowls, four cooking pots, three jugs and juglets and four storage jars. While this accumulation may be random, it may be related to a combination of primary and secondary activities that took place at this building. However, these activities remain unclear.

An accumulation of bird and rodent bones was found in two structures of the cellars house ([Figure 4.2](#)). In locus 1138, adjacent to the staircase leading to the building, 18 bird bones were found. In locus 1360, an underground room, seven rodent and three bird bones were found. Wapnish and Hesse (2000:444–5) report on a large corpus of micro fauna found at a corridor of a temple structure in Tel Megiddo. They suggested that an accumulation of small fauna may indicate that the structure was not used for a period of time and was used as a nesting area for owls or other raptors. It is possible that the accumulation

of microfauna at the staircase and the underground room, in Tel Beer-Sheba, is also related to the owls' activity.

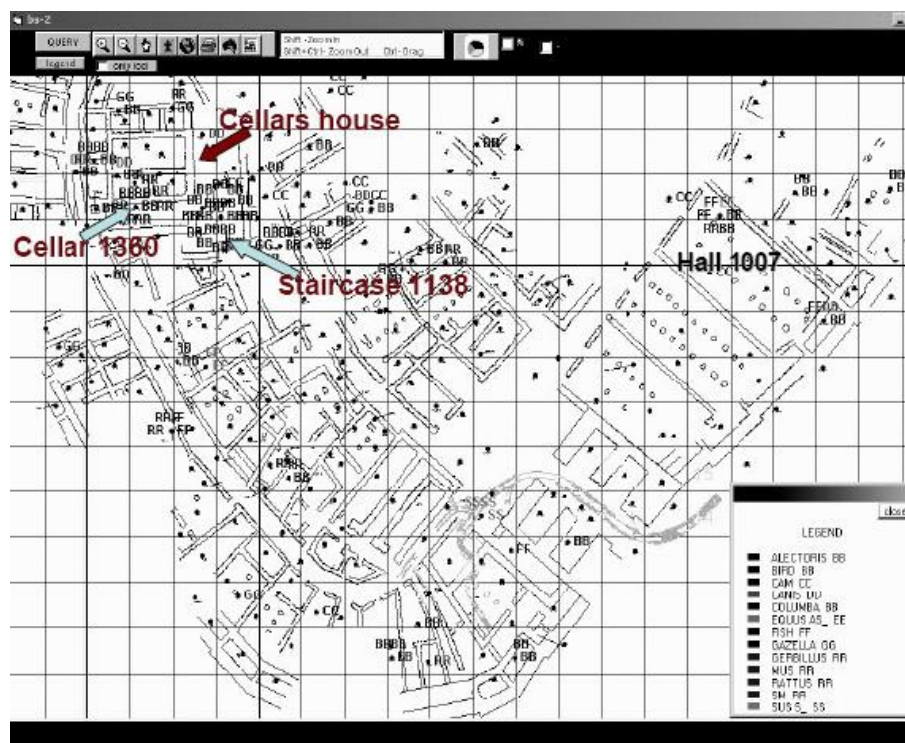


Figure 4.2 Spatial distribution of rare species (birds, fish, camel, dog, ass, rodents). Note the accumulation of microfauna in staircase 1138 and cellar 1360.

Caprine and Cattle Bone Distribution

The distribution of over 4000 identified bones of caprines and cattle was examined. No spatial pattern was found: caprine and cattle bones were found mixed in most loci and spread throughout the site (Figure 4.3). It is worth noting that the absence of caprine and cattle bones from the western quarter (for description of the Western Quarter see Beit Arie 1973b) and from most of the storehouse loci is due to the fact that faunal remains were not collected when these loci were excavated in the late 1960s.

The caprine/cattle ratio was tested statistically in selected loci (Table 4.2, Figure 4.4) and was compared with the general data from Stratum II. No significant difference was found between the data of each locus and the entire corpus of Stratum II ($\chi^2 = 82.62$, $df = 4$, $p < 0.001$). If caprine and cattle bones were absent from particular regions of the site, one could assume that some areas were designated for consumption of food and others were not. The spatial distribution analysis shows that the primary food animals were consumed in all regions and buildings of the site, regardless of their function.

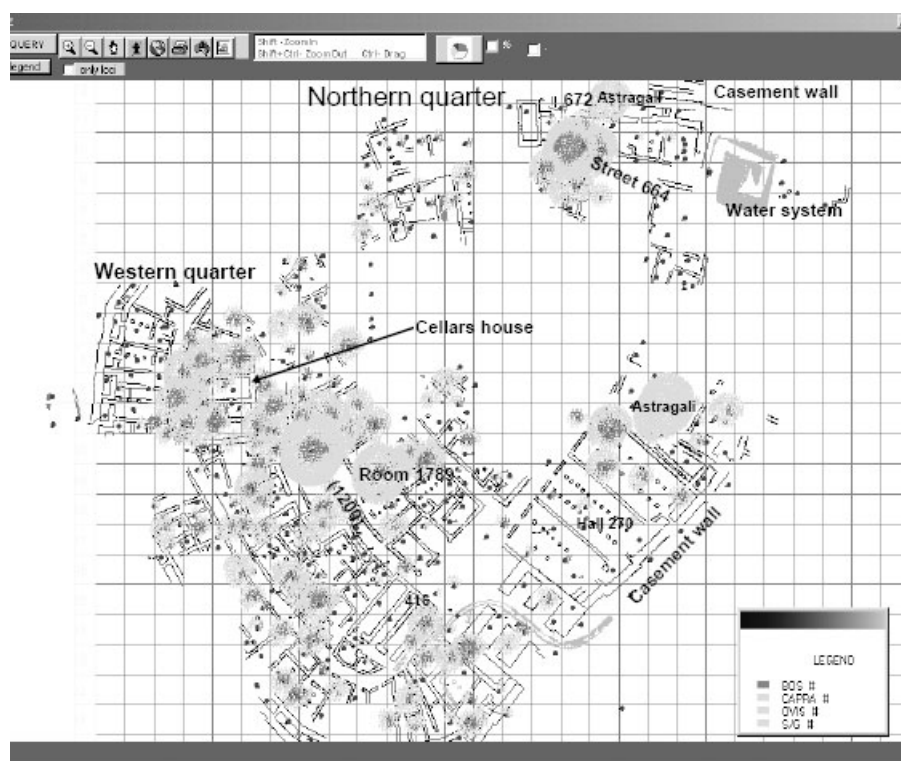


Figure 4.3 Spatial distribution of caprines and cattle.
Caprines: light grey; Cattle: dark grey

<i>Locus</i>	<i>Caprines</i>	<i>Cattle</i>	<i>Total</i>	<i>Caprines in %</i>
Street 664	265	64	329	81
Storeroom 1007	99	33	132	75
Street 1200	357	20	377	95
Room 1789	210	3	213	98
Cellar 1262	97	9	106	92
Stratum II whole	3512	568	4080	85

Table 4.2 Relative frequency of caprines in selected loci and in Stratum II.

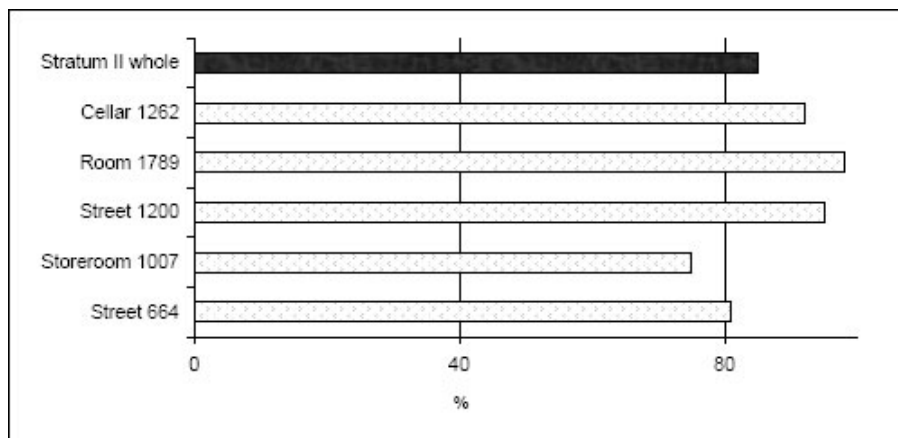


Figure 4.4 Relative frequency of caprines in selected loci and in Stratum II.

Sheep and Goat Bone Distribution

The distribution of over 1000 identified bones of sheep and goats was examined, with no spatial pattern to be found. The sheep and goat bone assemblage included approximately 700 astragali (Sasson 2007). The spatial distribution of sheep and goats was also examined, excluding the astragali. In both cases (with and without the astragali), sheep and goat bones were found mixed in most loci and spread throughout the site (Figure 4.5). The sheep/goat ratio was tested statistically in selected loci (Table 4.3, Figure 4.6) and the general data from Stratum II. No significant difference was found between the data of each locus and the entire sheep and goats assemblage ($\chi^2 = 9.368$, $df = 6$, $p = 0.154$) showing that the ratio between these species is proportionally represented in their spatial distribution.

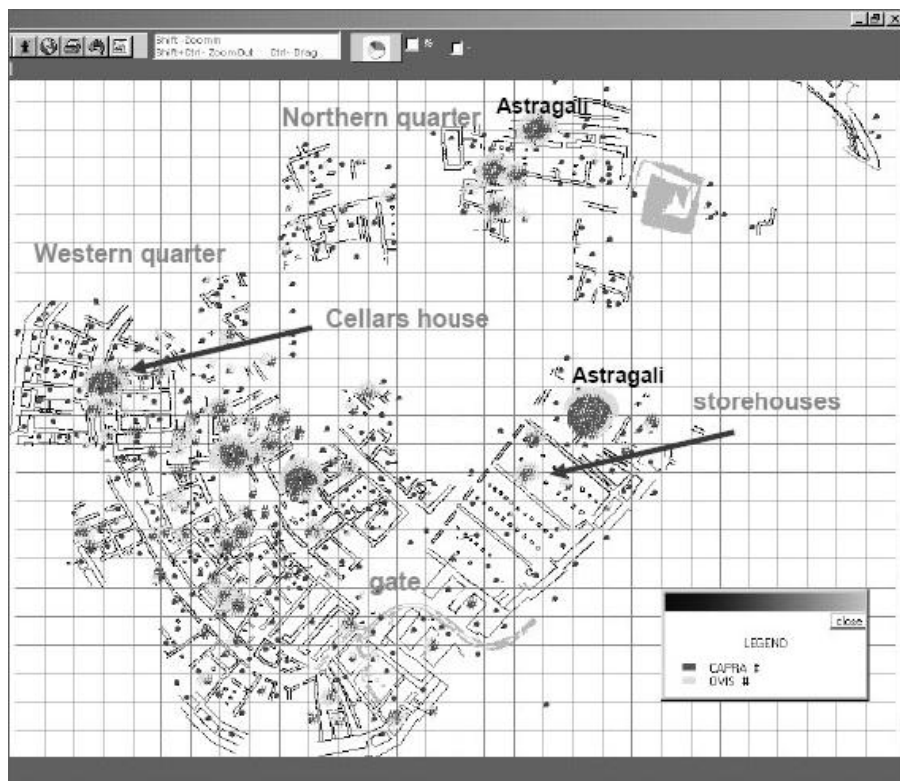


Figure 4.5. Spatial distribution of sheep and goats. Sheep: light grey; Goats: dark grey
Sheep: light grey; Goats: dark grey

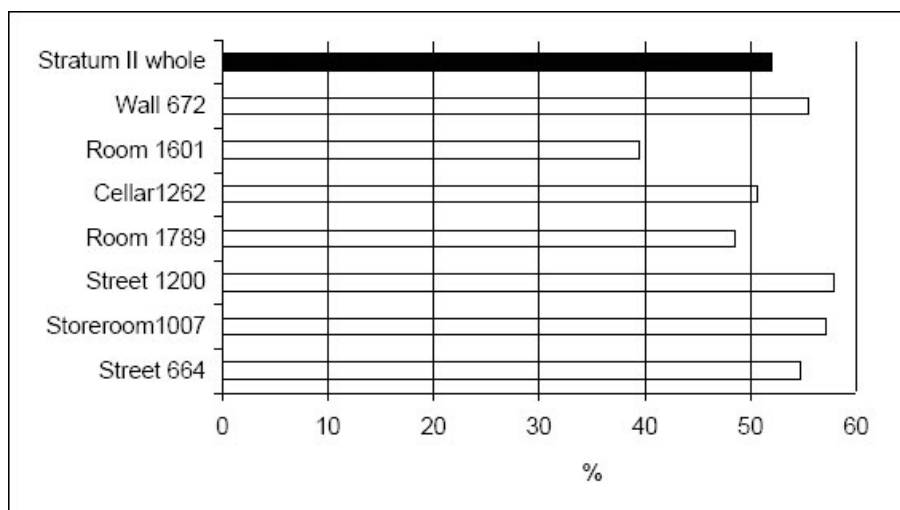


Figure 4.6 Relative frequency of sheep in selected loci and in Stratum II.

<i>Locus</i>	<i>Sheep</i>	<i>Goat</i>	<i>Total</i>	<i>Sheep in %</i>	
Street 664	29	24	53	55	
Storeroom1007	16	12	28	57	
Street 1200	40	29	69	58	
Room 1789	34	36	70	49	
Cellar1262	34	33	67	51	
Room 1601*	53	81	134	40	*astragali
Wall 672*	30	24	54	56	*astragali
Stratum II whole	568	445	1013	52	

Table 4.3 Relative frequency of sheep and goats in selected loci and in Stratum II.

Body Part Distribution and Social Stratification

Many scholars have defined Tel Beer-Sheba in the Iron Age as an administrative, political and military center or as a royal citadel (Aharoni 1973:17; Dever 1995a:418–19; Fritz 1995:176–7; Lemche 1996; Herzog and Singer-Avitz 2004:226; Finkelstein and Silberman 2006:139). According to Holladay (1995:382–90), the urbanization process in the 9–8th centuries BCE was one of the reasons for the evolution of social stratification and elite class. Hopkins (1996:124–8) points out two dichotomous economic centers in the Iron Age II: the rural economy, which was autarkic, and the urban economy, which was characterized by redistributive centers. Lemche (1996), argues that a patronage society evolved in the Iron Age II. Patronage centers (including Tel Beer-Sheba) were inhabited by an elite society that ruled the lower class population residing in rural settlements. Singer-Avitz (1999:54–60), defines Tel Beer-Sheba as a gateway community in the southern Arabian trade route. She studied the ceramic corpus of the northern quarter in Stratum II and suggested that it was inhabited by official figures, perhaps military people, who were provisioned with prepared foods (Singer-Avitz 1996:170–1, see also Faust 2002:311).

Previous studies show that the zooarchaeological record may reflect social stratification. Sites or areas in a site that were inhabited by upper class populations would contain a relatively high number of meat-rich body parts and young animals (see discussion above). Two hypotheses are tested here: (a) Tel Beer-Sheba as a political center was inhabited by an upper class population; (b) only designated areas in Tel Beer-Sheba were inhabited by elites while others were inhabited by lower class population. In order to test these hypotheses, skeletal elements of caprines and cattle were grouped into two categories of high and low food utility (Binford 1978:74–83 and see [Chapter 5](#) for a discussion on food utility). For instance, the meat-rich group includes the limb bones, pelvis and scapula, and the meat-poor group includes

feet and cranial bones (Table 5.4). The spatial analysis of high and low food utility skeletal elements refutes both hypotheses: rich-meat and poor-meat body parts were found in all areas of Stratum II and were found mixed in most loci (Figure 4.9). The distribution of body parts was tested statistically in seven selected loci (Table 4.4, Figure 4.7). No significant difference was found between the data from each locus and the entire assemblage of Stratum II ($\chi^2 = 15.52$, $df = 6$, $p = 0.017$).

A spatial analysis was also carried out on caprine and cattle bones based on age class. The age data for both species were combined and were assigned to three age groups: juveniles that died before the age of one year; sub-adults that died between the ages of one and three years, and adults that died at the age of three years or older. We may hypothesize that a high frequency of young animals would be found in areas inhabited by elites (see for instance Miller and Burger 1995). Figure 4.10 shows no spatial pattern in the distribution of the three age groups. Caprine and cattle bones of juveniles, sub-adults and adults are found in all areas of Stratum II and are found mixed in many loci. Mortality profiles of caprines were created in seven loci that consist of relatively large samples (Figure 4.8). No significant difference was found between the data of each locus and the general mortality profile.

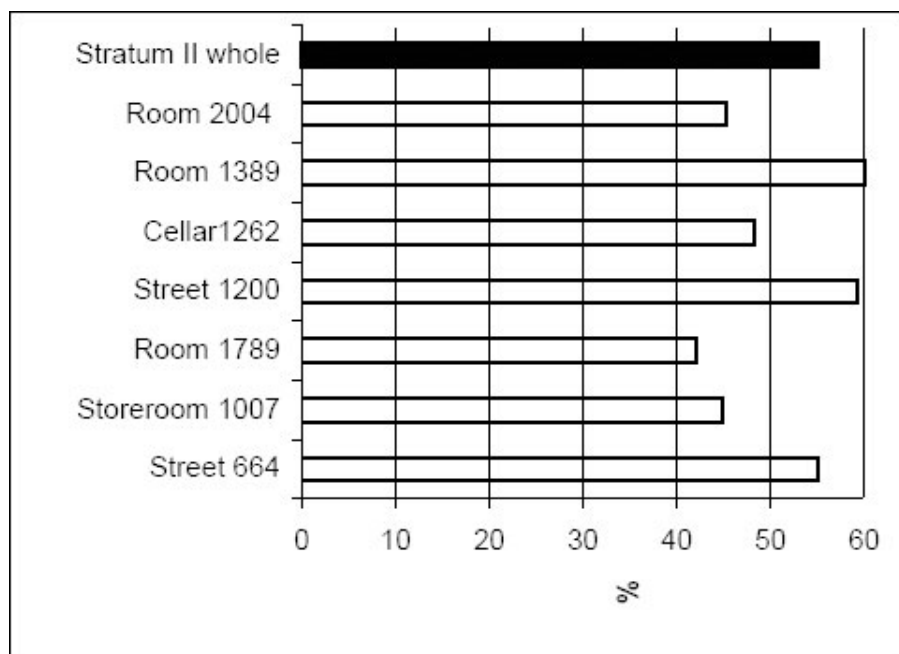


Figure 4.7 Relative frequency of meat-rich body parts in selected loci and in Stratum II.

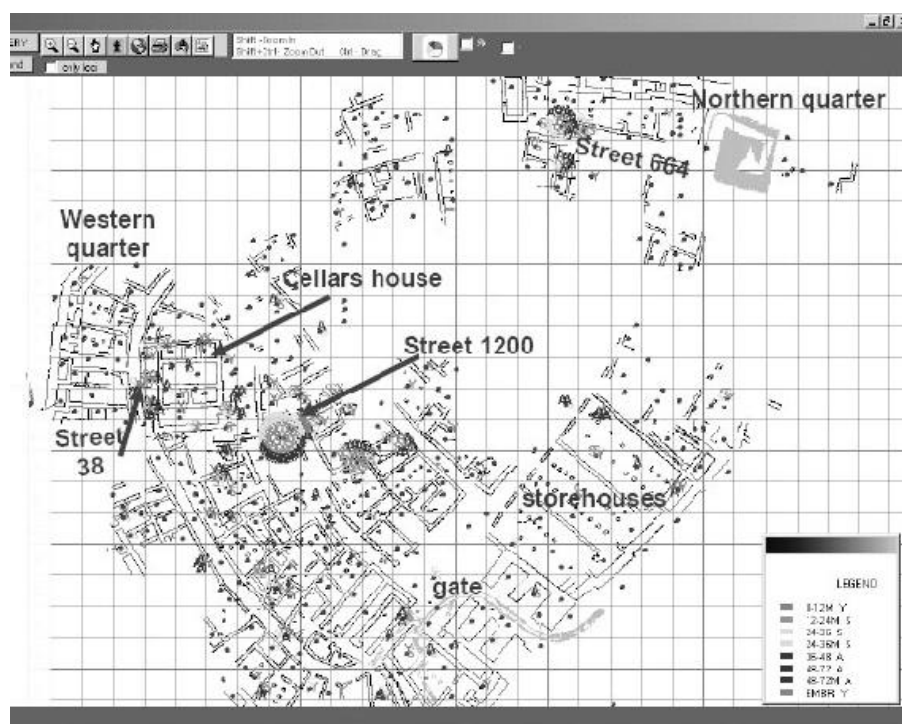


Figure 4.10 Spatial distribution of caprines and cattle according to their age class. Young animals – light grey; sub-adults – medium grey; adults – dark grey.

Skeletal elements	Street 664	Storehouse 1007	Room 1789	Street 1200	Cellar 1262	Room 1389	Room 2004	Structure II whole
ATLAS	3	0	2	4	1	0	0	15
AXIS	1	1	1	1	0	0	0	23
CALCANESUS	1	1	4	9	0	0	2	62
CARPAL + TARSAL	1	2	9	7	1	1	3	33
SKULL + HORN	7	6	7	17	5	1	0	99
METAPODIALS	16	13	32	40	3	7	9	370
PHALANX I	3	6	24	21	3	3	1	151
PHALANX II	4	2	16	3	0	2	4	52
PHALANX III	0	1	4	3	1	0	4	22
Total meat-poor	36	32	99	105	14	14	23	807
FEMLUR	7	3	5	19	1	3	1	76
HUMERUS	3	3	11	24	2	4	2	148
MANDIBULA	9	3	13	30	2	2	2	180
PELVIS	5	7	14	23	5	3	4	180
RADIUS	10	4	19	19	2	1	3	154
SCAPULA	3	5	4	15	0	6	2	124
TIBIA	3	1	6	23	1	2	3	124
Total meat rich	44	26	72	153	13	21	19	986
Grand total	80	58	171	258	27	35	42	1793

Table 4.4 Relative frequency of meat-rich and meat-poor body parts in selected loci.

In conclusion, the spatial analysis supported by the statistical tests shows no indication of social stratification in Tel Beer-Sheba or in the various areas of

Stratum II. LaBianca (1999:21) has made an important observation: 'Whereas in Egypt and Mesopotamia, the rise of supra-tribal polities in the form of centralized states led to a division of society into two realms-urban elite and rural tribesmen—no such pronounced division of society into occurred in the Iron Age kingdoms of the Southern Levant'.

The evidence from Tel Beer-Sheba and LaBianca's remark highlight three cultural and methodological issues:

1. The analysis of the of spatial distribution of animal bones from Tel Beer-Sheba strongly supports the disparity between Mesopotamia and the Southern Levant. The faunal remains from Stratum II were comprised of a wide range of skeletal elements and age classes indicating that caprines and cattle of all ages were consumed at the site and in various regions of the site. It is apparent that models of food consumption and indirect provisioning that are based upon the Mesopotamian context (Zeder 1991), are not congruent with the Southern Levantine context. In the Southern Levantine context, one should not expect to observe a market economy or urban sites that functioned as marketplaces or redistribution centers.
2. As discussed in [Chapter 2](#), it appears that archaeologists and zooarchaeologists analyze social complexity in antiquity through Western eyes. Evidently, socioeconomic status can be observed in ancient Egypt and Mesopotamia. However, the question to be asked is whether a dichotomy between the elite and the lower class populations was evident in the Southern Levant as well. This issue begs a further investigation.
3. As shown above, social stratification can be reflected in faunal remains. Nonetheless, not many studies of faunal assemblages point to a social complexity among Southern Levantine populations. This may be a result of the small number of studies addressing this issue.

Astragali Spatial Distribution

History and use of the astragalus bone. The astragalus is the anklebone that in mammals connects the leg to the foot. As an archaeological relic, the astragali (knucklebones) phenomenon is ubiquitous and can be observed over a wide spatial and temporal dimension (all five continents and over ten thousand years, cf. Lovett *et al.* 1901; Koerper and Whitney-Desautels 1999; Dandoy 2006). Finds of astragali are frequently described in the archaeological, anthropological and ethnographic literature. Dandoy (2006), in a recent paper, reviews the astragali phenomenon as it occurs in various art forms such as skeuomorphs, decoration and incising in many regions, including Egypt, Iraq, Iran, Ethiopia, Italy and the Americas. Gilmour (1997) lists numerous sites with astragalus bone finds spanning the Chalcolithic, Bronze and Iron Age in Israel, Turkey, Syria, Lebanon, Cyprus and Greece. Astragali from various sites in the

Levant are also portrayed by Frick (2000:65–8) and Hesse and Wapnish (1985:56). According to Gilmour, the largest cache of astragali in the Levant (684 in number) was found in Megiddo Stratum IVB-VA (Gilmour 1997:168, see also Hesse 1995b:224). Venturi (2006) recently described two groups of 37 and 43 astragali from Tell Afis in Syria. He asserts that they were deposited at the foundations of two different walls during their construction. The walls are dated to the end of the 12th century BCE.

Astragali were used as objects for divination or as gaming pieces. It is not surprising that this particular bone was chosen for these activities since it is compact and dense and it lends itself to tossing and rolling. Because of its compactness and density, it tends to be preserved through time. The bones fit well in the human hand, including the hand of a child; they have four distinct sides and land randomly when rolled.

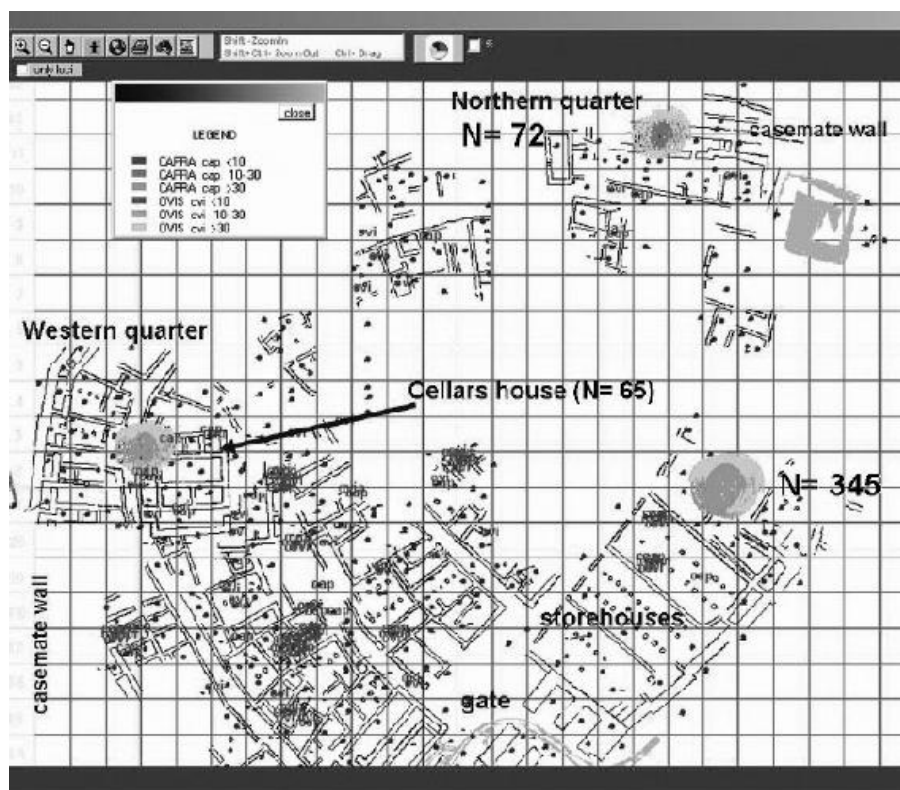


Figure 4.11 Astragali spatial distribution.
Sheep: light grey; Goats: dark grey

<i>Modification Marks</i>	<i>Goat</i>	<i>Sheep</i>	<i>Sheep or Goat</i>	<i>Total Modification Marks</i>
Burn	93	82	171	346
Burn and Cut	37	34	54	125
Ground	8	5	6	19
Burn and Ground	19	20	5	44
Cut	25	22	3	50
Burn, Cut and Ground	7	6	3	16
Cut and Ground	4	5	1	10
Burn and Drill	3	1	1	5
Burn, Ground and Drill	2	0	0	2
No Modification Marks	23	29	25	77
Total	221	204	269	694
Burn Total				538
Ground Total				91
Cut Total				201

Table 4.5 Modification marks on astragali from Stratum II.

The way astragali were used is repeatedly invoked in literature as well (see comprehensive reviews in Lovett *et al.* 1901; Gilmour 1997; Dandoy 2006). Lewis (1988) for instance, suggests that astragalus-based games were introduced to the natives of the southeastern United States by the Spanish in the 16th century. Koerper and Whitney-Desautels (1999) review evidence on the use of astragali as a gaming piece among California Native Americans. According to MacGregor (1985:134) astragali were used for a variety of children's games until the last century. Bar-Oz (2001:212) reviews some of the evidence of astragali games in the Greek and Roman cultures in the Mediterranean region. He also describes a unique find of an inscribed astragalus with a dedication to Hermes that was found in a water cistern dated to the Hellenistic period in Sha'ar-Ha'amakim (ibid:211). An anonymous author portrays the use of various mammal astragali for divination among the Zulu tribes in South Africa at the end of the 19th century (Anonymous 1898).

Astragali from Tel Beer-Sheba. A remarkable number of caprine astragali (n=694) was unearthed in Stratum II (Sasson 2007). The number is striking when compared to cattle astragali from the same context, 25 specimens only. The MNI count shows that the astragali originated in 374 individuals. Based on criteria suggested by Boessneck (1969:351–2), 221 specimens were identified as goat astragali with MNI of 127 and 204 were identified as sheep with a MNI of 110. Other astragali could not be identified as either sheep or goat.

Approximately 50% of the astragali from Stratum II (n=345) originated in locus 1601, situated near the storehouses (Figure 4.11). All the astragali were burned, most likely during the destruction of Stratum II (associated with a

fierce fire). The area in which they were found was is partially excavated and the ceramic evidence is fairly poor and does not cast much light on the nature of of this locus. Nevertheless, the proximity of locus 1601 to the storehouses may suggest it was part of the storehouse complex. In a storeroom adjacent to locus 1601 (loci 282 and 1004), an additional group of 20 astragali was found. According to Lapp (1964:27–8), 140 astragali were found in a storage room of a cultic structure in Tel Taanach (see also Frick 2000:65). The large number of astragali found in proximity to the storehouses suggests that they may have been used as tokens. These tokens could have been used either in the exchange of or for the counting of merchandise. It should be noted that a large number of astragali from locus 1601 bear cut marks ($n = 100$, 29%) and nine astragali are polished.

A group of 72 astragali was found in a casement room in the northern city wall (Figure 4.11). The ceramic evidence of this locus consisted of a small number of juglets, a bowl, a cooking pot and a storage jar, all complete vessels.

A group of 62 astragali was found in one of the cellar rooms of the cellar house (locus 1262, see Figure 4.11). The ceramic evidence of this locus consisted of a large number of juglets and a small number of bowls and cooking pots. In addition, a small number of loom weights and iron arrowheads were found in this locus (Aharoni 1975).

Small groupings of 10 to 30 astragali were found in various dwellings (loci 1407, 1441, 1058) and at a locus defined as a street (locus 1258, see Figure 4.11). The ceramic evidence from room (locus) 1441 is rich and consisted of a large number of bowls, cooking pots, juglets and storage jars.

Evidently, the ceramic and architectural context associated with the astragali is domestic for the most part. However, the spatial analysis of the astragali does not provide us with a better understanding of their distribution. Their spreading over a number of areas in Stratum II may suggest that they were used primarily as gaming pieces rather than for divination. If Tel Beer-Sheba astragali were used for divination, we could deduce that divination was domestic rather than cultic and was carried out in many households rather than by one distinguished figure such as an oracle.

A GIS spatial analysis was also carried out on the identified sheep and goat astragali. No difference in the spatial distribution of astragali according to species was found (Figure 4.11). Sheep and goat astragali were treated as one by Tel Beer-Sheba inhabitants and thus are found mixed in all areas of Stratum II (Sasson 2007).

Most astragali bear one or more modification marks, caused by burning, drilling, cutting, grinding and polishing (Table 4.5). I shall discuss each modification mark separately.

Over 77% ($n=538$) of the astragali in Stratum II are burned (partially or completely). As mentioned above, this is most likely a result of a fierce conflagration that occurred during the destruction of Stratum II rather than of cooking practices. It is evident that a large number of these astragali are burnt

heavily inside and out while fewer are scorched at their cortex (Figures 4.12 and 4.14). This indicates that the astragali were already severed from the skeleton by the time the fire occurred and were thus exposed directly to the flames.

Cut marks found on astragali are normally an indication of skinning (Binford 1981:106–107; Bunn and Kroll 1986:432; Grayson 1989:648–9). Table 4.5 shows that 29% (n=201) of the astragali bear cut marks (Figures 4.13 and 4.16). This indicates that astragali, even if intended for divination, were not treated differently than other body parts during the butchery practice. Twenty-six of the ground astragali (see below) bear cut marks as well. It is reasonable to assume that if astragali had been considered valuable artifacts, cut marks would not be found on these bones. This is particularly true in regard to the ground astragali that were apparently used as gaming pieces or for divination.

Over 13% of the astragali found in Stratum II are ground or polished (Figures 4.14 and 4.16). Modifications were made on the lateral and medial areas of the astragalus in order to flatten bony protuberances. This was probably done to enable the bone to land more accurately on these sides. Ground astragali were also found in locus 2520 in Tel Beer-Sheba, Stratum VII (Hellwing 1984:112), Middle Bronze Tel Shechem (Seger 1972), Iron Age Tel Dor (Lisk 1999:62–3) and at Tel el-Ajjul, Beth Shean and Megiddo (Gilmour 1997). According to Lewis (1988:759), we may distinguish between astragali used as dice and those used as gaming pieces. He suggests that dice astragali would have ground surfaces while gaming pieces would not. The evidence from this work neither supports nor refutes his assumption.

A relatively high percentage of ground astragali was found in Loci 672 (n=12, 6%), 1262 (n=20, 31%), 1441 (n=8, 37%) and 1449 (n=7, 47%).

Drilling or perforation of astragali frequently appears in archaeological and ethnographic records (cf. Gilmour 1997; Dandoy 2006). The drilled holes are normally filled with lead or copper and, rarely, with other metals. The supplementary metal made the astragalus mass heavier and easier for tossing (Dandoy 2006:133). Seven astragali from Stratum II were found drilled (Figures 4.14, 4.15, 4.16 and Table 4.5). The small number is probably related to the scarcity of metals. Given that the drilled astragali were found in five different loci (1058, 1262, 1345, 282, 845) and were not cached, we may deduce that they were not considered more valuable than the others.

Astragali: Conclusion

The remarkable number of astragali recovered in Stratum II of Tel Beer-Sheba is additional evidence for the ubiquitous phenomenon observed in all five continents over the past 10,000 years. The spatial analysis of Stratum II shows neither a pattern in the distribution of sheep versus goat bones nor a pattern in their distribution associated with location or modification (i.e. drilling, cutting, grinding). The outstanding number of specimens and the modification marks

found on many of them clearly indicate that they were intentionally collected and used by Tel Beersheba inhabitants. However, the evidence does not directly support the two common uses related to astragali—for divination and as gaming pieces. The group of 345 astragali found in proximity to the storehouses suggests that that they may have been used as tokens. These tokens could have been used either in the exchange of or for the counting of merchandise (Sasson 2007).



Figure 4.12 Astragali from Stratum II, Tel Beer-Sheba. Note the heavily burnt astragali.



Figure 4.13 Cut marks on astragali.



Figure 4.14 Ground astragali, lateral view.



Figure 4.15 Drilled astragali.

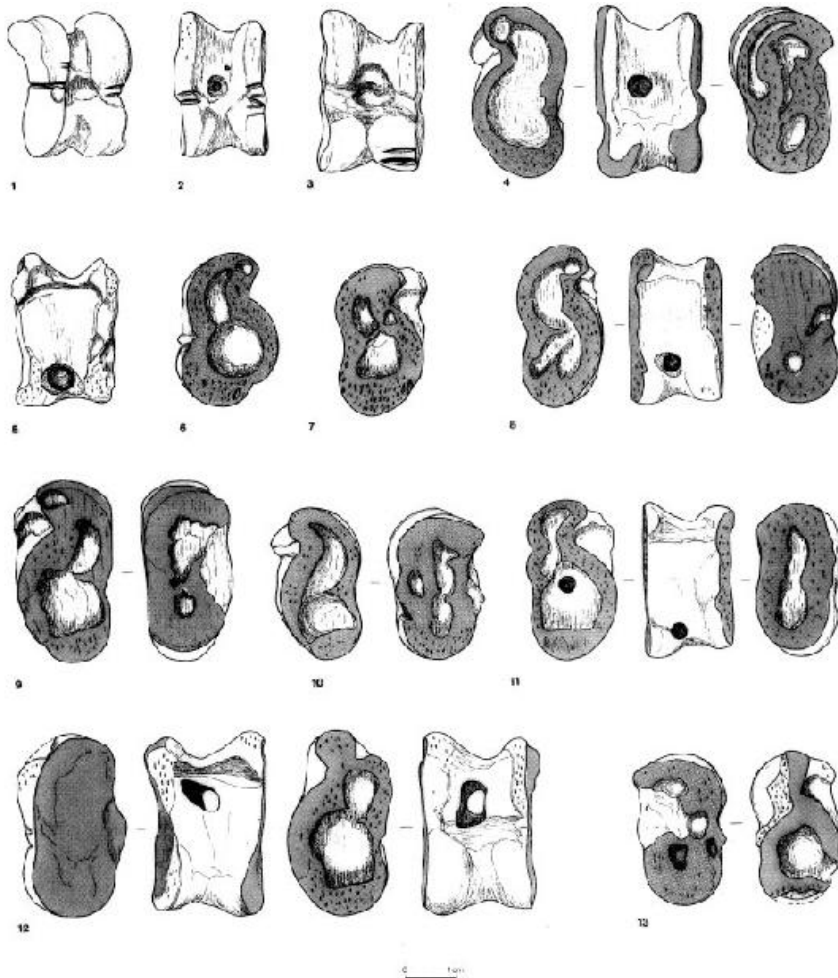


Figure 4.16 Astragali showing cut marks (1, 2, 3), grinding (4, 6, 7, 8, 9, 10, 11, 12, 13) and drilling marks (4, 8, 9, 11, 12)

A Sagittal Perspective: Taphonomic Study of Tel Sites—A Case Study from Tel Beer-Sheba

Introduction

A tel (artificial mound) in the ancient Near East may be defined as a composition of occupational strata, destruction levels, and to a lesser extent, naturally deposited sediment (A.M. Rosen 1986:9). Tel formation is, in the main, a result of cultural activity indicating human occupation over perhaps thousands of years (Renfrew and Bahn 1991:54). The primary building blocks of a tel are mud brick, stone, ceramics, some occasional lime plaster, and organic refuse (A.M. Rosen 1986:11–12). The formation of tels evolved in the late prehistoric periods, and for the most part, in the historic periods starting with the Early Bronze Age (approximately 3200 BCE). Normally, the common zooarchaeological finds in tel sites are of animals used for human consumption (i.e. caprines, cattle and in some cases pigs).

Taphonomy is the study of a preservation of an organism (faunal remains in our case) over time. The representation of skeletal elements in archaeological sites is conditioned by a variety of taphonomic processes that include biotic and abiotic, pre-depositional and post-depositional processes (Hill 1978; Marean *et al.* 1992:118). Taphonomic analysis is widespread in prehistoric studies (Lyman 1994b) yet rarely implemented in studies of tel sites. Studies of body-part utilization (Hellwing and Gophna 1984:51–4; Horwitz 1989a:52; Zeder 1984; Landon 1997:58; Stokes 2000:146), body-part representation (Davis 1987b:29; Payne 1975; Grigson 2006:234) and density mediated attrition (Meadow 1978:18–19, Hesse 1996:110) in tel or historic sites have been carried out, however they were not part of a comprehensive taphonomic study. Only a small number of studies of sites from historical periods is primarily focused on taphonomic aspects (e.g. Landon 1992; Loyet 1999). Consequently, the methods applied in this study were adopted largely from taphonomic studies of prehistoric sites.

The significance of taphonomical analysis for interpreting archaeological contexts has been articulated numerous times (Binford 1977:6–7; Binford 1978; Klein and Cruz-Urbe 1984; Marean *et al.* 1992; Lyman 1994b; Bar-Oz and Dayan 2002). Landon has recently reviewed the current state of the zooarchaeological research in historical archaeology. He stresses that not enough progress has been done in employing taphonomic methods to the study of faunal remains and concludes: ‘Given our growing understanding of taphonomic processes, we have reached the point where interpretations of animal bone assemblages that ignore the effects of taphonomic processes on assemblage patterning must be considered incomplete’ (Landon 2005:6). This notion can be demonstrated on a study of Kirch and O’Day (2003). They

examined the relative frequency of Polynesian rat bones (*Rattus exulans*) among commoner and elite households in a site in Kahikinui, Maui, dated to the 17th and 18th century CE. They argue that the abundance of rat remains associated with commoner households compared with their scarce remains in elite households indicates that commoners often consumed rats while the elites did not. The scarcity of rat remains at the elite households may be related to social differentiation but may also be also related to taphonomic agents such as fluvial transport processes, post-depositional and attrition agents or differences in methods of bone collecting (see discussion below). An additional case study to demonstrate the importance of taphonomic studies, is Tel Beer-Sheba. The spatial distribution analysis of faunal remains from Stratum II shows that 65% of the bones were found in interior loci ([Chapter 4](#)). This phenomenon may be attributed to cultural practices. Taphonomic study of the bone assemblage, however, indicates that the reason for the low frequency of faunal remains in exterior loci may also be density-mediated attrition (see discussion below). These examples emphasize that the taphonomic study of faunal remains in Maui, Tel Beer-Sheba or any other site should precede a social or economic interpretation.

This study demonstrates a comprehensive taphonomic analysis carried out in a tel site. It examines a sequence of taphonomic agents that altered the bone assemblage from the stage the animals were slaughtered to the stage their remains have reached the zooarchaeological lab. In the first phase, the death assemblage (Klein and Cruz-Urbe 1984:3), body part representation and their food utility was examined to assess the effect of humans on the bone assemblage. In addition, a quantitative analysis of cut marks, generated by humans, was carried out. The subsequent phase examines pre-depositional agents such as dog ravaging and fluvial transport processes that may have affected the bone assemblage. The third phase, the fossil assemblage, studies the effect of post-depositional processes on bone attrition and bone fragmentation. In the fourth and final phase, the effect of the archaeological excavation on faunal assemblages was examined. Two factors were studied: the relationship between freshly broken bones (resulting from the archaeological dig) and their relative frequency and the relationship between the size of skeletal parts and their relative frequency. The four phases of investigation represent common processes that most bone assemblages undergo before they reach the zooarchaeological lab. The results of this study provide a greater understanding of the nature of zooarchaeological assemblages as well as an anthropological perspectives on the diet, economy and social structure of the Tel Beer-Sheba inhabitants.

Phase One: The Death Assemblage

In the first phase of analysis, two questions were addressed: which body parts were available to the Tel Beer-Sheba inhabitants and how were they utilized?

Cut Mark Analysis

A significant indication on animal exploitation in Tel Beer-Sheba is the high frequency of cut marks displayed on bones. Evidence for cut marks created by metal tools (Greenfield 1999) was observed on 25% of the caprine and cattle bones that were available for taphonomic study (Table 5.1).

Ethnoarchaeological studies are useful for the understanding of butchery practices (e.g. Binford and Bertram 1977:90–5; Jones 1980; LaBianca 1995b:25–6; Loyet 2000:29). Binford defined the relationship between cut marks on particular body parts and various butchery activities (Binford 1978:48–51; Binford 1981:98–147). According to Binford's typology (see also Bunn 1983; Maltby 1985; Bunn and Kroll 1986; Shipman 1986; Grayson 1989; Rabinovich *et al.* 1996; Bar-Oz *et al.* 1999), skinning activities will lead to cut marks on lower limb and cranial bones, filleting will be reflected in cut marks on meat-bearing bones and dismemberment will result in cut marks on joints.

The frequency of cut marks (in percentage) was calculated by dividing the number of caprine and cattle bones with cut marks by the total number of specimens (NISP) per anatomical category (Table 5.1, for discussion of this method see Bunn and Kroll 1986; Lyman 2005). The data presented here rejects Lyman's hypothesis that bones of larger taxa display more butchery marks than bones of the smaller taxa (Lyman 1992b; 2005). The average cut marks on caprine bones (25.6%) and cattle bones (24.3%) is similar. The data analysis points to a systematic butchery practices. The frequency of caprine and cattle cut-marked bones is strongly correlated with the total NISP per anatomical category (Table 5.1; $r=0.97$, $p<0.05$ for caprines; $r=0.83$, $p<0.05$ for cattle). Indications for skinning were found primarily on the distal metapodials, phalanx I and astragali of cattle and in caprines, on the distal metatarsals, distal metacarpals and astragali. In order to study the carcass dismemberment, body parts were grouped into six anatomical categories (Table 5.2), which represent primary skeletal joints (Lyman 2005). The frequency of cut-marked joints of caprines is strongly correlated with the number of specimens per joint ($r=0.98$, $p<0.05$). The frequency of cut-marked joints of cattle is moderately correlated with the number of specimens per joint, but not statistically significant ($r=0.60$, $p=0.20$). This might be related to the small sample of cattle bones in some of the categories such as wrist and knee. Nevertheless, the strong correlation (Zar 1996:371–79) between the proportion of cut-marked joints of cattle and caprines ($r=0.83$, $p<0.05$) points to a systematic pattern in dismemberment of body parts of both species.

A high proportion of cut marks was found on several meat-rich body parts such as the humerus, scapula, pelvis and radius of caprines and cattle (Table 5.1), pointing to a filleting activity. An additional indication for filleting is the positive correlation between MUI (meat utility index; Binford 1978:73) and the frequency of cut marks on skeletal elements of caprines ($r_s=0.58$, $p<0.05$).

In sum, it is evident that caprines and cattle in historical sites were utilized for food. The cutmarks study from Stratum II provides us with quantitative

measures and demonstrates a strong correlation between the relative frequency of cut marks and all stages of butchery, skinning, dismemberment and filleting.

Body Part Representation and the Utilization of Caprines and Cattle

Tel Beer-Sheba was defined as an administrative and regional town centre (Aharoni 1973:17; Dever 1995a:418–19; Herzog and Singer-Avitz 2004:226; Finkelstein and Silberman 2006:139). As discussed in [Chapter 2](#), models of food consumption propose that urban centers were provisioned with meat-rich body parts (Zeder 1984; 1988; 1991:33–44, Crabtree 1990:164; LaBianca 1995a:61; Stokes 2000:151). This model was tested in Tel Beer-Sheba using two methods to analyze the body part representation. The first method groups body parts into two categories; slaughter offal and consumption refuse ([Table 5.3](#)–offal; for discussion on this method see Hellwing and Gophna 1984; Hesse and Wapnish 1985:100–1). The weakness of this method is that it does not consider the economic variables per skeletal element and it is based only on a NISP count. Some skeletal elements, such as ribs and vertebrae, may be over-represented in this method. The weakness of this method is also its strength: it enables us to include non-distinctive skeletal elements such as vertebrae, ribs and cranial parts in the analysis (Shipman 1981:128). If the town of Tel Beer-Sheba was provisioned with selected body parts, it would be reasonable to assume that the proportion of the consumption refuse category would be considerably larger. The data in [Table 5.3](#) rejects this assumption; the proportion of both categories in caprines and in cattle is similar. Hence, it is concluded that both species were slaughtered and consumed at the site.

Anatomical Category	Caprines			Cattle			MUI (meat)	MGUI Sheep
	NISP	Cut marks	% cut	NISP	N cut	% cut		
Distal Metapodials	34	4	12	30	8	26	5.55	10.1
Distal Metatarsal	32	7	22	4	0	0	6.37	12.11
Proximal Metatarsal	57	5	9	9	2	22	6.37	15.77
Proximal Metacarpal	21	5	24	10	0	0	4.74	10.11
Distal Metacarpal	66	22	33	2	0	0	4.74	8.45
Proximal Humerus	15	7	13	5	0	0	28.24	37.28
Distal Humerus	131	56	43	20	10	50	28.24	37.29
Distal Femur	30	23	76	7	2	29	28.24	80.58
Proximal Femur	36	15	42	14	1	7	28.24	80.58
Distal Radius	26	3	12	4	1	25	14.01	20.06
Proximal Radius	36	15	42	20	9	45	14.01	24.3
Distal Tibia	72	7	10	16	0	0	20.76	37.7
Proximal Tibia	37	12	32	5	2	40	20.76	51.99
Pelvis	132	35	27	15	4	27	81.3	81.5
Scapula	61	11	17	27	5	19	44.89	45.06
Phalanx I	130	19	15	33	12	36	3.37	8.22
Phalanx II	51	2	4	24	5	21	3.37	8.22
Astragalus	691	191	28	22	6	27	6.37	23.08
Calcaneus	62	11	18	16	2	12	6.37	23.08
Atlas i Axis	37	7	19	9	2	22	18.65	18.68
Grand total	1763	452	24.9	392	71	20.4		

Table 5.1 Relative frequency of cut marks on caprine and cattle skeletal elements.

Anatomical Category	Caprines			Cattle		
	NISP	Cut marks	% cut	NISP	Cut marks	% cut
Shoulder ¹	75	13	17	32	5	16
Elbow ²	163	70	43	40	19	48
Wrist ³	47	8	17	14	1	7
Hip ⁴	168	50	30	29	5	17
Knee ⁵	67	35	52	12	4	33
Ankle ⁶	885	214	24	63	10	16
Total/average	1405	390	28	190	44	23

1 Scapula, proximal humerus

2 Distal humerus, proximal radius

3 Distal radius, proximal metacarpal

4 Pelvis, proximal femur

5 Distal femur, proximal tibia

6 Distal tibia, proximal metatarsal, astragalus, calcaneum

Table 5.2 Relative frequency of cut marks on primary anatomical regions of caprines and cattle.

<i>Skeletal group</i>	<i>Caprines</i>		<i>Cattle</i>	
	<i>NISP</i>	<i>%</i>	<i>NISP</i>	<i>%</i>
Skull (excluding teeth) ¹	366	31	33	15
Feet ²	597	51	109	51
Toes ³	203	17	73	34
Total of slaughter offal	1166	46	215	49
Trunk ⁴	496	37	77	35
Hindquarter ⁵	414	31	64	29
Forequarter ⁶	437	32	80	36
Total of consumption refuse	1347	54	221	51

1 Mandibula, maxilla, horncore, cranium

2 Metatarsal, metacarpal, metapods, calcaneum, astragal, carpal, tarsal

3 Phalanges

4 Vertebrae, sternum, rib

5 Pelvis, sacrum, femur, tibia

6 Scapula, humerus, radius, ulna

Table 5.3 Relative frequency of slaughter offal and consumption refuse of caprines and cattle.

The second method examines the economic utility of skeletal elements and their relative frequency. Binford (1978:72–4) constructed the modified general utility index (MGUI) by measuring the amount of associated meat, marrow and grease for each carcass part that was available for human consumers. Metcalfe and Jones (1988) suggested a standardized food utility index (SFUI), which measures food utility for a complete bone rather than the articular ends, as measured by Binford (e.g. complete femur rather than distal femur and proximal femur). Binford (1978:77–83) proposed a family of hypothetical utility curves that would be represented in scatter plots derived by plotting the relative frequency of skeletal elements and their economic utility. Gourmet curves, for instance, represent strategies that select for high frequency of the highest utility value and abandon parts of moderate and low value. Binford’s method is frequently invoked in studies of hunter-gatherers (e.g. Thomas and Mayer 1983; Grayson *et al.* 1988; Metcalfe and Jones 1988; Grayson 1989; Klein 1989; Lyman 1992a; 1994b; Bar-Oz *et al.* 2004; Faith and Gordon 2006) but rarely used in studies of historical sites and sedentary population (e.g. Marean and Frey 1997; Loyet 1999; 2000). [Figure 5.1](#) presents the relationship between the relative frequency of skeletal elements and their %MGUI ([Table 5.4](#)) and SFUI ([Table 5.5](#)) values. The %MAU and %MGUI values of caprines are correlated and statistically significant ($r = 0.42$, $p = 0.04$) but those of cattle are

not statistically significant ($r = 0.32$, $p = 0.12$), which might be the result of a smaller sample of cattle bones (Faith and Gordon 2006:880). The picture that emerges from [Figure 5.1](#) is that none of the curves match a gourmet strategy. In other words, Tel Beer-Sheba was not provisioned with select body parts. This data is supported by the GIS spatial analysis carried out in Stratum II ([Chapter 4](#)) that showed that caprine and cattle body parts, of high utility and low utility, were found in all areas of the town and were found mixed in numerous loci.

In conclusion, the study of the body part representation, coupled with the spatial analysis, point to a food maximizing strategy (Monahan 1998:419–20; see also Reitz and Wing 1999:24; Driesch and Wodtke 1997:518). That is, caprines and cattle were butchered and consumed within the site and all their body parts were utilized. This clearly indicates a self-sufficient economy and disproves the hypothesis that Tel Beer-Sheba was provisioned with meat from outside sources. The study of sheep and goat exploitation in Tel Beer-Sheba shows that they were utilized for all their products (see Sasson 2008 and Chapters 2 and 3 here). This idea coincides well with the food maximizing strategy described above.

Phase Two: Pre-Depositional Processes

The second phase of analysis examines possible agents altering the faunal remains after animals were slaughtered and consumed. In this phase, the site is still inhabited and active or recently abandoned and the bone accumulation is exposed to the elements. Two agents that may have altered the bone assemblage were examined in this phase; domestic dogs or other carnivores, and fluvial transport processes.

Dogs as Attritional Agents

Seven bone fragments (MNI=1) were identified as domestic dog (*Canis lupus fam.*) in Stratum II. As discussed in [Chapter 1](#), the dearth of their remains should not be interpreted as reflecting their rarity and, it is reasonable to assume that dogs were active in Tel Beer-Sheba. Ethnoarchaeological studies show that dogs, which lived within settled sites, are the immediate factor acting on animal bones after they were tossed away by humans (Walters 1984; Marshall 1994; LaBianca 1995b; Ochsenschlager 2004:201). Experimental studies show that dogs have a substantial effect on bone destruction (Binford 1981:217–8; Kent 1981; Payne and Munson 1985; Lotan 2000; Castel 2004). Meadow (1978:16) refers to dogs as: ‘perhaps the single most important cause of bone destruction in the Middle Eastern sites’. Binford composed an index of survival percentage (SP) for sheep skeletal elements after dog ravaging (Binford and Bertram 1977:109; Binford 1981:218). The correlation between %MAU of caprines and cattle in Tel Beer-Sheba ([Table 5.4](#), column 2, 4) and

Binford's SP index (Column 8) is positive and significant ($r=0.81$, $p<0.01$ for caprines; $r=0.73$, $p<0.01$ for cattle). This may indicate that dogs may be associated with bone attrition. However, only a small number of gnawing marks was found on animal bones from Stratum II, which weakens this possibility. Binford and Bertram (1977:105) referred to the difficulty in assessing dog ravaging saying: 'One may not be able to recognize the presence of agent of attrition—such as dogs—through the simple comparison of patterns of bone survival'. In sum, it will be demonstrated below that density-mediated attrition agents altered the bone assemblage of Tel Beer-Sheba. Although the relative frequency of skeletal elements is correlated with Binford's SP index, the contribution of domestic dogs to altering the bone assemblage is difficult to assess.

Fluvial Transport Processes

It is reasonable to assume that the bone refuse of the 'last supper' of Tel Beer-Sheba inhabitants, before the town was destroyed and burned, composes a large portion of the potential zooarchaeological find. It is also reasonable to assume that these bones were exposed to fluvial transport processes immediately after the site was abandoned and before post-depositional processes took place. The Negev rain system is characterized by a relatively large number of flash floods (Evenari *et al.* 1971:109). A GIS spatial analysis of the faunal remains from Stratum II shows that only 35% of the bones were found outdoors while the majority of bones were found indoors (Chapter 4). This fact may indicate that bones, originally discarded outdoors by the town inhabitants, were washed away to a drain system and outside the town (for a description of the drain system in Tel Beer-Sheba see Aharoni 1973:14). Behrensmeyer (1975:572) constructed a saturated weight index (SWI) for the complete skeletal elements of sheep (see also Todd and Frison 1986:67–8). These values were normed into a scale of 1–100 (Table 5.5, column 8) and plotted against %MAU of complete skeletal elements of caprines and cattle (column 2, 4). No significant correlation was found between the two sets of data ($r=0.4$, $p=0.12$ for caprines; $r=0.19$, $p=0.46$ for cattle). Therefore, it is concluded that fluvial transport processes did not affect the bone assemblage in Stratum II.

Anatomical Category	1 MAU Caprines	2 % MAU Caprines	3 MAU Cattle	4 % MAU Cattle	5 MGUI Sheep	6 % MGUI Sheep	7 Bone density (Birford)	8 survival per- centage after dog ravaging	9 % fresh break caprines	10 % fresh break cattle	11 NISP caprines+cattle	12 % cattle of total (caprines+cattle)
Mandibula	90	100	8	39	43.6	53	1.76	100	(-)	(-)	196	8
Distal Humerus	66	73	11	78	32.8	41	1.72	81	38	57	152	14
Phalanx I	16	18	4	30	3.2	10	0.8	17	21	28	163	20
Scapula	62	69	14	100	45.1	56	1.69	82	(-)	(-)	151	18
Pelvis	90	100	8	56	81.5	100	1.71	80	(-)	(-)	195	8
Proximal Radius	59	46	10	81	24.3	30	1.65	80	30	32	118	16
Distal Tibia	40	44	7	52	37.7	47	1.69	71	61	71	94	15
Distal Metacarpal	35	38	1	0	8.5	10	1.35	47	43	0	70	1
Proximal Metacarpal	34	37	6	44	10.1	13	1.3	30	28	75	79	15
Calcaneum	31	34	8	39	23.1	29	1.55	68	32	44	78	21
Proximal Metatarsal	31	34	5	33	15.8	20	1.36	38	52	56	71	13
Phalanx II	7	7	3	22	8.2	10	0.8	14	4	17	76	32
Proximal Tibia	22	24	3	19	52.0	65	1.38	41	18	80	49	10
Proximal Femur	21	23	7	52	80.6	100	1.52	58	34	29	55	25
Distal Radius	19	21	2	13	20.1	25	1.52	60	38	25	41	10
Distal Metatarsal	18	19	2	15	12.1	15	1.31	30	34	50	39	10
Distal Femur	17	19	4	26	80.6	100	1.41	46	35	43	41	17
Horn	13	14	2	11	1.0	1	(-)	(-)	(-)	(-)	29	10
Axis	23	13	4	30	18.7	23	1.39	44	(-)	(-)	27	15
Phalanx III	3	3	2	15	8.2	10	0.78	12	9	25	38	42
Proximal Humerus	9	5	3	22	37.3	46	0.87	10	35	50	23	26
Atlas	15	17	5	37	18.7	23	1.5	58	(-)	(-)	20	25
Occipital	2	22	5	37	12.9	16	1.64	94	(-)	(-)	25	20
Articulation	(-)	(-)	11	81	23.08	29	1.53	57	3	27	(-)	(-)
Ulna				(-)	(-)	(-)	(-)	(-)	34	75	43	19
Tarsal				(-)	(-)	(-)	(-)	(-)	0	25	21	38
Carpal				(-)	(-)	(-)	(-)	(-)	5	9	31	35

Table 5.4 Relative frequency of skeletal elements of caprines and cattle and their MAU, MGUI and

density values.

Body Part	1	2	3	4	7	8
	MAU Caprines	% MAU Caprines	MAU Cattle	% MAU Cattle	SFUI	SWI Sheep
Mandibula	90	96	8	39	31	19.1
Humerus	74	79	13.5	100	37.1	27.7
Phalanx I	16	18	4	30	(-)	1.4
Phalanx II	7	7	3	22	(-)	0.5
Phalanx III	3	3	2	15	(-)	0.6
Phalanges (All)	26	27	9	66	19.4	(-)
Scapula	62	66	13.5	100	44.7	14.5
Pelvis	94	100	7.5	36	49.3	42.9
Radius	77	82	11.5	85	26	21.9
Tibia	62	66	9.5	70	62.8	27.7
Metacarpal	68	73	6	44	5.2	9.4
Calcaneus	31	33	8	39	27.7	3
Metatarsal	49	52	6.6	49	37	10.2
Femur	38	40	10.5	78	100	31.9
Horn	13	14	1.5	11	1	(-)
Axis	23	25	4	30	10.2	11
Atlas	15	16	5	37	10.2	10.4
Axis + Atlas	(-)	(-)	(-)	(-)	10.2	(-)
Occipital	20	21	6.5	48	9.1	(-)
Astragalus	(-)	(-)	11	81	27.7	2.3

Table 5.5 Relative frequency of complete skeletal elements and their SFUI and SWI values.

Phase Three: Post-Depositional Processes

The third phase of analysis studies the relationship between the post-depositional processes and bone destruction and fragmentation.

Density-Mediated Attrition

Density-mediated attrition comprises a wide range of non-human agents such as dog ravaging (see above), weathering, soil acidity, sediment overburden and plant roots that may alter a bone assemblage during the site formation. Obviously, before addressing cultural behavior that is reflected in faunal assemblages, one must address the relationship between bone density and its survivorship rates. Many studies, mostly of prehistoric sites, have addressed the issue of density-mediated destruction (Binford and Bertram 1977; Lyman 1984; Grayson 1989; Klein 1989; Loyet 1999; Bar-Oz and Dayan 2002; Munro and Bar-Oz 2005). Bar-Oz et al. (1999:69) studied the faunal remains from the Geometric-Kebaran site of Neve David in Israel (dated approximately 13,000 BP). They show for instance that the ratio of proximal humeri (low density elements) to distal humeri (with high density value) of gazelle and fallow deer (6:58 and 4:29 respectively) points to a density-mediated attrition that altered the bone assemblage. Although this analysis provides us with a clear

indication of density-mediated attrition, a comprehensive analysis of all skeletal elements is required.

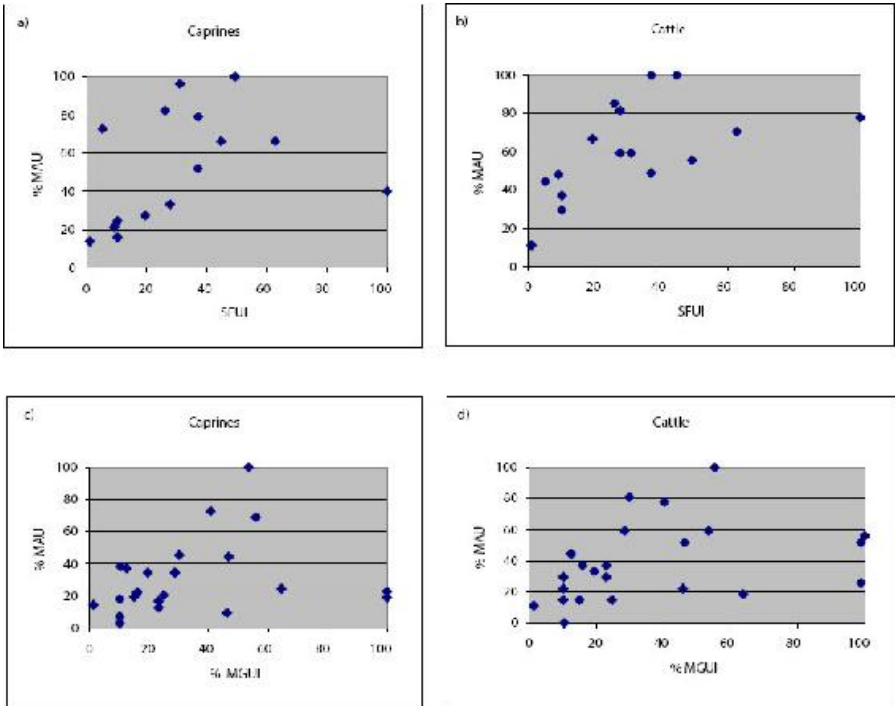


Figure 5.1 Relationship between utility indices and relative frequency of skeletal elements (a-SFUI, caprines, b- SFUI cattle, c- MGUI, caprines, d- MGUI, cattle).

There is an ongoing debate regarding the suitable method for measuring bone density. Three primary methods have been suggested for measuring skeletal element density:

1. Structural density, which denotes the ratio of bone mass to its volume and is normally displayed in gram/cubic centimeter (Brain 1969; Behrensmeyer 1975; Binford and Bertram 1977).
2. Photon densitometry, which computes bone mineral density by projecting photon beams through a skeletal element and measuring its strength (Lyman 1984; 1985; Ioannidou 2003; Symmons 2004; 2005).
3. Computer tomography (CT), which computes the mineral density of bones by measuring the photon attenuation from many different directions to reconstruct a detailed cross-sectional image of a scanned object (Lam *et al.* 1998; Lam and Pearson 2005).

While the structural density method measures general areas of a skeletal element (e.g. proximal humerus, distal femur), the photon densitometry and CT methods can measure the density of specific zones of the articular joint. Tel

sites are normally characterized by abundant zooarchaeological remains and the fragments are recorded to general categories such as distal femur or proximal humerus. Therefore, for the purpose of this study, the structural density method (Binford and Bertram 1977:109; Binford 1981:218) is suitable for evaluating the effects of density-mediated attrition. The relative frequency of skeletal elements of caprines (Table 5.4, column 4) and cattle (column 6) was tested against the structural density values (Table 5.4, column 7) and found to be strongly correlated (caprines: $r=0.72$, cattle: $r=0.61$) and significant ($p<0.01$ for both species). The results clearly indicate that density-mediated attrition altered the bone assemblage of Stratum II: denser skeletal elements survived better than less-dense elements.

Bone Fragmentation

Bone fragmentation is often studied in order to detect bone marrow extraction among hunter-gatherer groups (e.g. Binford 1978:145–56; Lyman 1984; Marshall and Pilgram 1991; Bar-Oz and Dayan 2002; Bar-Oz and Munro 2004; Munro and Bar-Oz 2005). Evidence for marrow processing in the Southern Levantine Bronze and Iron Age is rare. In addition, the bone assemblage of Stratum II was comprised of many large shaft fragments indicating that marrow extraction did not take place in Tel Beer-Sheba. Other causes for bone fragmentation could be post-depositional processes (Klein 1989; Marean 1991; Hesse 1996). In order to examine the fragmentation rates, the NISP:MNE ratios of caprines and cattle limb bones were studied (Table 5.6). MNE (minimum number of elements) is derived by tallying the percentage of preservation (see Chapter 3) per skeletal element and then dividing it by 100 (Klein and Cruz-Uribe 1984; Bunn and Kroll 1986; Marean 1991; Reitz and Wing 1999). For instance, four specimens of distal femur with a preservation of 30%, 50%, 70% and 80% add up to a MNE of 2.3 (230/100) and their NISP is 4. Thus, a higher NISP/MNE ratio points to a higher fragmentation (for discussion on the NISP and MNE see Lyman 1994a).

The fragmentation rates per skeletal element of caprines and cattle are strongly correlated ($r_s = 0.77$, $p = 0.02$). This may indicate a pattern in the fragmentation of skeletal elements regardless of species. However, in order to confirm this pattern, study of further bone assemblages is required.

Comparison of the fragmentation rates of caprines and cattle in Stratum II shows noteworthy results: all skeletal elements of cattle are more fragmented than those of caprines (Table 5.6). The average fragmentation rate of caprine bones is 3.3 (with 1.23 standard deviation) while for cattle, it is considerably higher—5 (with 1.28 standard deviation). A higher degree of fragmentation of large bovid bones has been observed in other studies as well (Klein 1989:374–5; Marean 1991:687).

Marshall and Pilgram (1991) examined the fragmentation rates in a Neolithic site in Kenya. They pointed to a pattern similar to this observed here

and they related it to marrow processing (see also Marshall and Pilgram 1993:263). Lyman has plotted the fragmentation rates reported by Marshall and Pilgram against the marrow (of sheep) and fat (of bison) utility indices (Lyman 1994b:281–2). He indicated that neither pair of variables is significantly correlated. I have plotted the fragmentation rates of caprines and cattle in Stratum II against the marrow and grease utility indices of sheep (Binford 1978:74). The results (Table 5.6) are congruent with Lyman's data: the NISP:MNE ratios of caprines and cattle are not significantly correlated with the grease utility index ($r = 0.03$, $p = 0.934$ for caprines; $r = -0.02$, $p = 0.958$ for cattle) nor with the marrow utility index ($r = -0.37$, $p = 0.362$ for caprines; $r = -0.35$, $p = 0.397$ for cattle). It is therefore suggested that post-depositional processes rather than marrow processing, were the cause of a relatively high fragmentation of cattle bones. A higher fragmentation of cattle bones is also observed in the study of fresh breaks (see below). A lower fragmentation of caprine limbs may be a result of their smaller circumference, which makes them less breakable and less sensitive to post-depositional agents.

An important implication on the relative frequency of species arises from this study. A higher fragmentation of cattle bones, compared to caprines, generates a bias towards cattle in the zooarchaeological record.

In order to assess the effect of post-depositional processes on faunal remains from tel sites, additional fragmentation studies need to be conducted. The possible relationship between fragmentation ratios and the overrepresentation of cattle is an excellent example of the necessity of taphonomic studies in tel sites.

Phase Four: The Archaeological Excavation

The fourth and final phase of analysis examined the effect of the archaeological excavation on the faunal assemblage.

Fresh Breaks (Fractures)

The term 'fresh break' refers to fractures, which occurred during the archaeological excavation or subsequent stages (e.g. transportation, storing). A fresh break was recorded only when a large portion of the identified specimen was observed as fractured. Splintered specimens, were not recorded as freshly broken. The relative frequency (in %) of freshly broken limb bones was derived from the total NISP per skeletal element, both in caprines and in cattle (Table 5.6). Evidence of fresh breaks was observed in 17.4% of the faunal remains. The frequency of fresh breaks per skeletal element in caprines is slightly correlated with that of cattle ($r = 0.43$, $p = 0.62$). In other words, the frequency of fresh breaks in the proximal radii, proximal femora and distal femora of caprines and cattle is correlated and may point to a pattern in their propensity to break. However, a study of additional bone assemblages from tel sites is necessary

before reaching any further conclusions.

The results of this study are striking: the frequency of fresh breaks in cattle bones is nearly twice that in caprines (30% compared to 16%). That is, during the archaeological dig, the number of cattle bone fragments nearly doubled in the NISP count compared to caprines. A similar pattern emerged from our study of post-depositional processes and fragmentation of caprine and cattle bones (see above). The studies of fragmentation and fresh breaks that are presented here and other studies of fragmentation in large versus small mammals (Klein 1989; Marean and Spencer 1991; Bar-Oz and Dayan 2003) indicate that large mammal bones (e.g. cattle) are more exposed to breakage than smaller mammal bones (e.g. caprines) due to their larger size and circumference. The taphonomic study in Tel Beer-Sheba also indicates that the archaeological excavation as well as post-depositional processes inflated the representation of cattle in the bone assemblage.

Bone Size

The relationship between faunal remains collecting in the archaeological excavations, bone size, and the representation of species in the zooarchaeological record was discussed in previous studies (Payne 1975; Zohar and Belmaker 2005; Davis 1987a:29; Crabtree 1996:61; Zeder 1991:103; Grigson 2006:216, 234). All studies show that hand-collecting of faunal remains and the absence of sieving will bias against the recovery of small vertebrates. The archaeological and zooarchaeological project of Tel Hesban (Jordan) also demonstrates the collecting bias towards cattle (see [Chapter 2](#)). While the relative frequency of cattle in the enumeration of live animals is 4% (30 out of 758 animals), it increases to 6.5% on the bone collecting (33 out of 510 bones) and ranges from 8.7% to 17.4% in the zooarchaeological record ([Table 5.7](#)). It is apparent that the relative frequency of cattle and the difficulty in retrieving the faunal remains increases correspondingly due to the larger size of cattle skeletal elements.

The frequency of cattle in Stratum II is 14-15%, more than expected in a semi-arid climate (Sasson 2005a). The proportion of cattle skeletal elements (in %) was computed by dividing the NISP of cattle by the total NISP of caprines and cattle for each skeletal element ([Table 5.4](#), column 11, 12). The correlation between the NISP of skeletal elements of caprines and cattle is positive and significant ($r_s = 0.64$, $p < 0.05$). A Chi Square test was carried out on each skeletal element. It is apparent that the relative frequency of most body parts does not differ significantly between caprines and cattle. However, a significant difference between caprines and cattle is found in several skeletal elements: Phalanx II ($\chi^2 = 12.25$, $p = 0.0005$), Phalanx III ($\chi^2 = 17.65$, $p < 0.0001$), carpals ($\chi^2 = 7.81$, $p = 0.0052$) and tarsals ($\chi^2 = 6.84$, $p = 0.089$). Namely, a bias towards cattle appears in these skeletal elements. An overrepresentation of caprines was found in two skeletal elements: mandible ($\chi^2 = 11.73$, $p = 0.0006$) and pelvis ($\chi^2 = 13.91$, $p = 0.0002$). The overrepresentation of small body parts of cattle is striking. While the mean cattle proportion in the NISP count is 15%, the representation of its small skeletal elements ranges from 32% to 42% ([Table 5.4](#), column 12). In view of the absence of sieving at the Tel Beer-Sheba excavation (Herzog pers. comm.), it is likely that the archaeologist in the field failed to spot many small body parts of caprines while the same skeletal elements of cattle were collected.

In sum, this study statistically supports previous inferences of collecting bias towards cattle generated by the archaeological dig. The study of bone size and the fragmentation and fresh break analyses point to an overrepresentation of cattle in zooarchaeological assemblages.

Conclusions

I have argued that taphonomy will find its important role in archaeology as the art of spoiling. It is about interferences. It is that set of practices, which concern non-historical research factors, factors

which need consideration before, or at least in tandem with, factors which concern themselves with social custom or behavior. Taphonomy is a pre-requisite to any discussion of what has taken place in concrete landscapes. Taphonomy underlines archaeological work, surrounds it, and relates aspects one to the other (Walters 1990:21).

The main purpose of this chapter was to methodologically demonstrate the necessity of taphonomic investigation before or in tandem with the discussion on animal husbandry in a tel site. Archaeological sites from historical periods are characterized by copious finds and vast amounts of information (e.g. architectural, ceramic and zooarchaeological data). As a result, taphonomic investigation is neglected. The foundations of a vicious circle has thus been laid down; the importance of taphonomic analysis in tel sites has not been demonstrated and for this reason, taphonomic studies are not promoted. Consequently, very few taphonomic studies of tel sites have been carried out so far.

In order to evaluate the necessity for taphonomic investigation in tel sites we shall review the results yielded from the taphonomic study of Tel Beer-Sheba:

<i>Stages of qualification</i>	<i>Caprines</i>	<i>Cattle</i>	<i>Total</i>	<i>%Cattle</i>
Animal census*	728	30	758	4.0
Bone collecting*	477	33	510	6.5
Hesban Iron Age I	1827	385	2212	17.4
Hesban Iron Age II	3732	356	4088	8.7
Hesban Roman	3309	419	3728	11.2
Hesban Mamluk	6901	1107	8008	13.8

* In Contemporary Hesban

Table 5.7 Cattle proportion at the village of Hesban in various periods.

1. The analysis of body part representation indicates that livestock (caprines and cattle), were not imported from outside markets. They were butchered and consumed at the site. Analysis of the frequency of skeletal elements and their utility indices (Binford 1978; Metcalfe and Jones 1988) points to a food maximizing strategy, namely, all body parts, those of high utility as well as those with low utility, were consumed at the site. These results do not coincide with models of food consumption by elite and urban populations. In [Chapter 2](#), I have discussed at length the survival subsistence strategy (see also Sasson 2005a, 2008). One of the pillars of this strategy is the optimal utilization of resources, which is refelected in the food maximizing strategy that is described above.
2. A quantitative study of cut marks points to systematic butchering practices. All three primary stages of butchering (i.e. skinning,

dismembering and filleting) were identified in this study. This study is an additional indication that caprines and cattle were butchered and consumed at the site.

3. The relative frequency of skeletal elements and their saturated weight (Behrensmeyer 1975) did not correlate. It indicates that the fluvial transport processes did not alter the bone assemblage of Stratum II before post-depositional processes had taken place.
4. A strong correlation between the relative frequency of skeletal elements and their density was found. Evidently, post-depositional processes altered the bone assemblage of Tel Beer-Sheba. Dense skeletal elements survived these processes better than less-dense ones.
5. The analysis of fragmentation occurring during the post-depositional processes shows that fragmentation ratios (per skeletal element) of caprines and cattle are strongly correlated, which may point to a fragmentation pattern. The analysis shows that cattle bones were more fragmented than caprine bones, indicating an overrepresentation of cattle in the bone assemblage.
6. Similar patterns were observed in the analysis of fresh breaks occurring during the archaeological excavation. Skeletal elements of caprines and cattle have similar fragmentation ratios. Cattle bones, broken during the archaeological dig, generated more fragments than those of caprines, also indicating an overrepresentation of cattle in the bone assemblage.
7. A study of the relative frequency of skeletal elements and their size shows that the small skeletal elements of cattle are overrepresented compared to the average proportion of cattle in the bone assemblage of Stratum II.
8. A qualitative analysis of fragmentation, fresh breaks and bone size demonstrates that cattle are overrepresented in the NISP count in Tel Beer-Sheba and most likely in many other tel sites.

These conclusions shed light on the faunal assemblage as well as on the socio-economic environment of the site. The analysis of body part representation and their utility indices as well as the analysis of cut marks indicate that caprines and cattle were bred, butchered and consumed at the site. Although Tel Beer-Sheba was defined as an administrative centre (Aharoni 1973:17; Herzog and Singer-Avitz 2004:235), the town was not provisioned with livestock from outside markets. This observation could have not been made without a comprehensive taphonomic study. Models suggesting that urban sites are provisioned by select skeletal elements, species and age (Zeder 1991:33–4; Wapnish and Hesse 1988:83–5; Crabtree 1990:164) appear inapplicable in the Southern Levantine context. Another example of the necessity of taphonomic research for understanding the socio-economic contexts is the various studies discussing the role of cattle in the economy of the Bronze and Iron Age (Grigson 1995; Tchernov and Horwitz 1990; B. Rosen 1986; Finkelstein and

Silberman 2001:115; Sasson 2005a and see Chapter 2). These studies base their conclusions on the relative frequency of cattle. As demonstrated above, at least three taphonomic phases may cause an overrepresentation of cattle in the bone assemblage. Discussions of the relative frequency of cattle that neglect to address fragmentation, fresh break and bone size are thus lacking key factors for assessing this issue.

In sum, as demonstrated here, taphonomic analysis has a great importance for better understanding faunal assemblages as well as the socio-economic context of sites from historical periods. Additional taphonomic studies of tel sites should be encouraged. They are essential to creating a database for comparison and for identifying taphonomic patterns related to the unique tel formation.

An Ethnographic Perspective: Animal Husbandry and Human Diet—Ethnographic Study of Premodern Villages in Mandatory Palestine

Introduction

The aim of this chapter is to shed more light on animal husbandry and herd management in antiquity and to evaluate the contribution of animal products (meat and milk) to the human diet. This ethnographic study is based on data collated from the British census carried out in the 1940s (Government of Palestine 1943; 1945).

During the British Mandate in Palestine, a number of censuses were carried out (Barron 1922; Mills 1932; see also Finkelstein 1992a and Moscrop 2000 for additional sources on the British censuses). In the early 1940s, the British Mandatory Government carried out detailed censuses, which provide us with demographic data per village, the size of built-up areas and agricultural lands as well as the number of livestock and their distribution to species, sex and age (Government of Palestine 1943; 1945).

It should be noted that modern agricultural technologies were not prevalent in the Arab villages surveyed by the British censuses (Hirsch 1933:20–31; Hurwitz 1966:23–4; Perevolotsky and Landau 1992:18). Hirsch (1933:36) discussed animal husbandry and herd management among the Arab farmers in the 1930s. He stresses the fact that agriculture was carried out without the benefit of modern techniques and that ‘the raising of domestic animals is still primitive’ (Hirsch 1933:36). This allows us a unique opportunity to examine traditional animal husbandry not yet enhanced by modern technology using a rare statistical database of agricultural practices.

The Research Area

In order to obtain a broad picture of the pastoral component in the economy of premodern villages, I have studied the statistical data of Arab villages situated in diverse geographical regions in the Central Hill Country, which ranges from 650 to 950 meters in altitude (for the geography of the region and its subdivisions see Finkelstein 1988:125–9; Finkelstein 1997b:103–8). This study has examined four different geographic regions in the Central Hill country (Figure 6.1). Each region is represented by one premodern village. The economy of this village was analyzed using the statistical data from the British census.

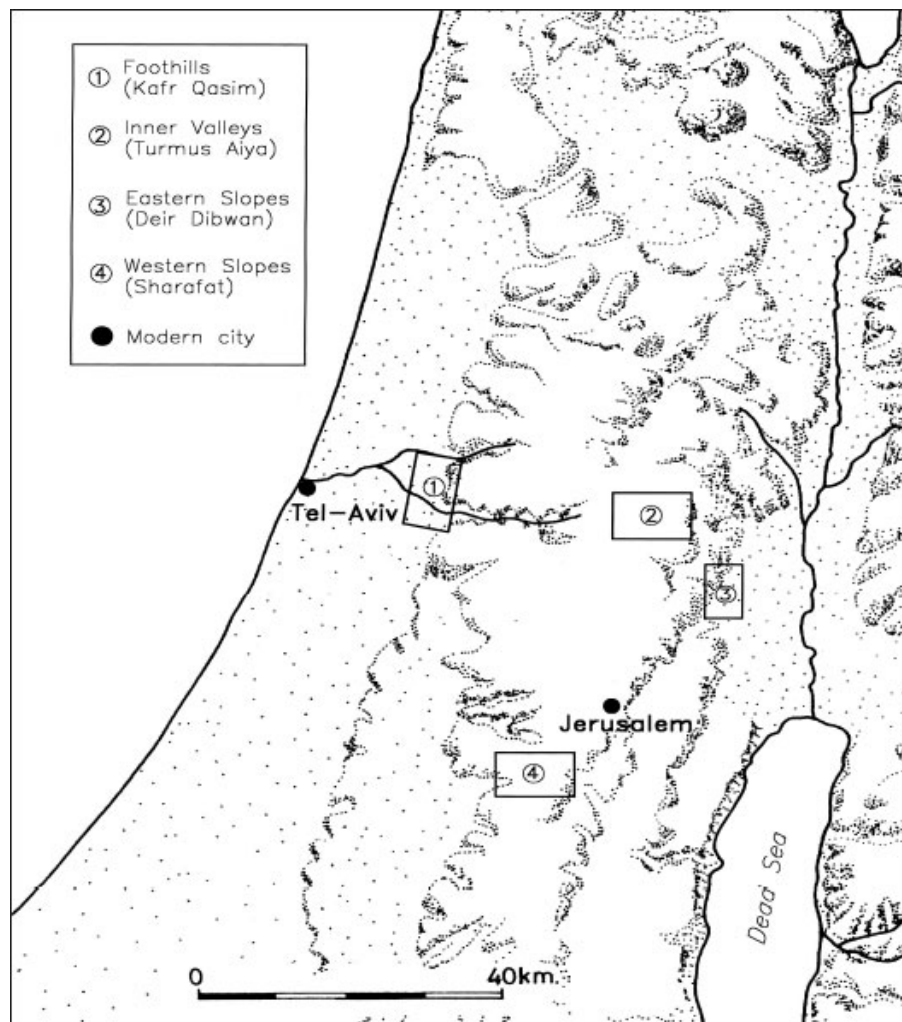


Figure 6.1 The studied regions in the Central Hill country.

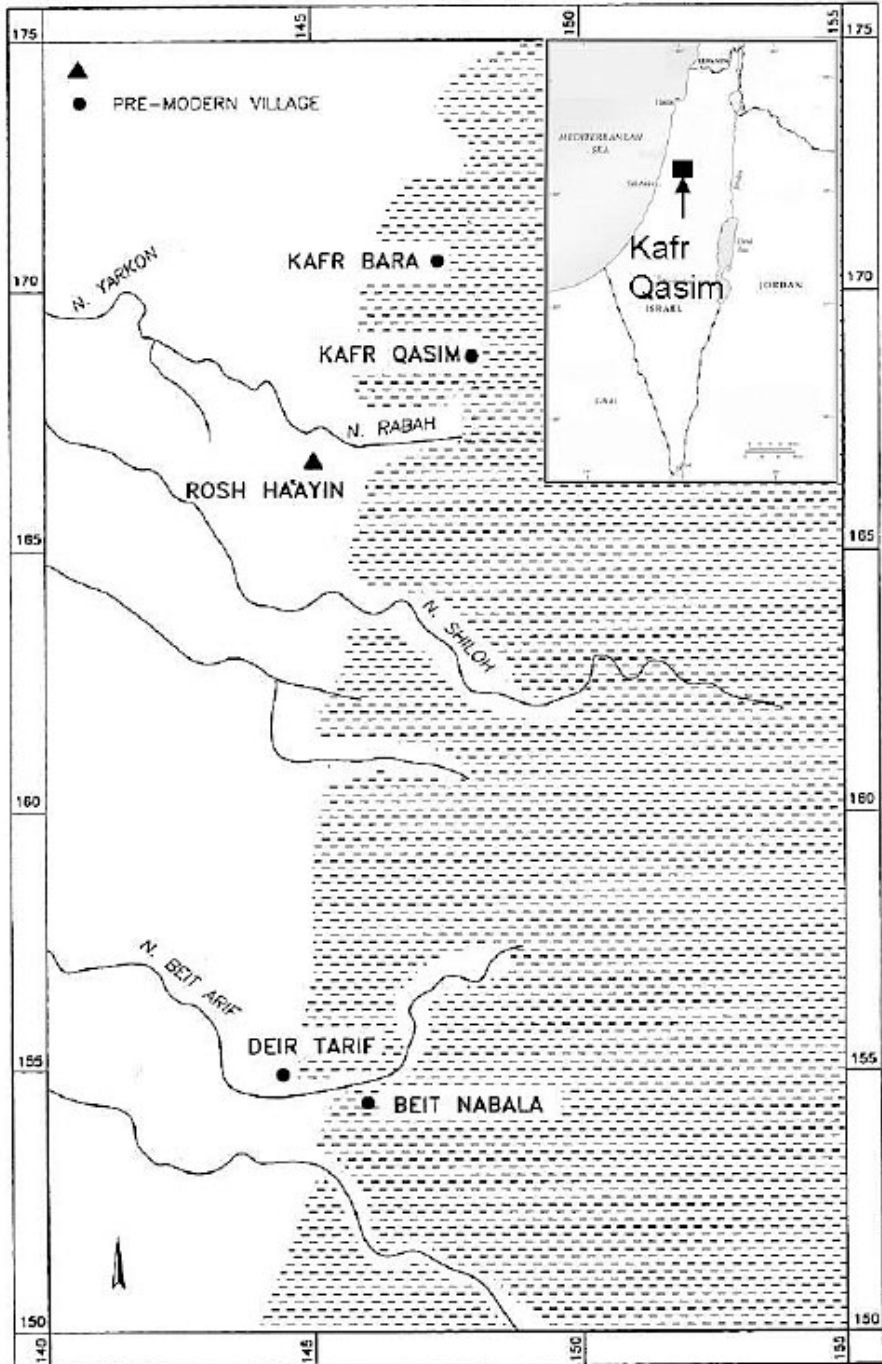


Figure 6.2 The Western Foothills region.

The four studied regions are:

1. *The Western Foothills*: located on the margin of the Coastal Plain

- (Figures 6.1; 6.2), covering ca.150 sq km. The area consists of low generally rolling hills and agricultural land. The climate is Mediterranean (mean annual rainfall of 600 mm). The economy of the premodern village of Kafr Qasim, located in this region will be analyzed. This village will also be used to demonstrate the methodology of this research.
2. *The Inner Valleys*: located in the northern mountain ridge (650–850 m above sea level). The region is characterized by wide agricultural valleys (ca. 2 sq km each) and it covers about 220 sq km. The region's climate is Mediterranean. In this area, the village of Turmus Aiya was studied (Figure 6.1).
 3. *The Eastern Slopes*: the region is situated east of the mountain crest and extends over approximately 330 sq km. It is characterized by long mild slopes (Figure 6.1). This area is drier than the other regions (less than 400 mm mean annual rainfall). The economy of the premodern village of Deir Dibwan, located in this region, was analyzed.
 4. *The Western Slopes*: located west of the mountain ridge (Figure 6.1). The area covers 450 sq km. This region is characterized by long steep slopes, separated by deep ravines running east-west. The region's climate is Mediterranean. In this region, the economy of the premodern village of Sharafat was studied.

Methodology

In order to verify that the economy of the village chosen for this study represents the economy of its region, additional villages in the same region were examined and used as a control group. Key parameters reflecting animal husbandry and agricultural practices in the principal village and the control group were compared and evaluated. These parameters comprise the relative frequency of main livestock used for consumption and labor (sheep, goats and cattle) and the distribution of land use (e.g. plantation and cereal cultivation). All parameters were measured in percentages of total land or species. The data of the principal village was compared with the average values of the control group (Figure 6.3).

The village of Kafr Qasim situated in the Western Foothills will be used here to demonstrate the methodology of this research. Three other villages in this region were used as a control group, Kafr Bara, Deir Tarif and Beit Nabala (Figure 6.2). The data in Figure 6.3 does not point to a significant difference between Kafr Qasim and the control group. Hence, the economy of Kafr Qasim may be used to study the economy of the Foothills region. This method was carried out in the other studied regions (Sasson 1998:5–6).

As stated above, the purpose of this research is to evaluate the role of animal husbandry in the traditional rural economy. This assessment is based on nutritional elements such as meat, milk, fat, protein and calories that are produced by livestock. The relative contribution of these elements to the

human diet was compared. The animal census carried out by the British mandatory government of Palestine provides us with a detailed information on the distribution of livestock to species, sex and age per village (Government of Palestine 1943). This information was collated and virtual herds of caprines and cattle were built per village (Table 6.2 and 6.3). The term ‘virtual’ is used because it represents the total number of caprines and cattle in each village (over 1300 animals in Kafr Qasim, for example), although obviously they were originally composed of several smaller herds (Sasson 1998:8–9). The virtual herds were comprised of caprines (sheep and goats) and cattle, the most common species in mandatory Palestine and the main source of meat and milk. It is noteworthy that the compositions of the sheep herds is similar to these of goats, which points to a uniform herd management and slaughter patterns. It is also striking that the sex and age composition of the caprine herds in all studied villages is very similar, approximately 10–15% of male lamb/kid; 20–25% female lamb/kid; 3–5% ram/male goat and 50% ewe/female goat (Figure 6.4). This fact points to a prevalent herd management (for similar observations see Payne 1973:301; Wapnish and Hesse 1988:83–5; Abu Rabia 1994:55; Borowski 1998:57), which focuses on females that were vital for the herd reproduction and milk production (see Chapter 2). This age profile indicates that traditional caprine herding did not specialize in a particular product (meat, milk or wool).

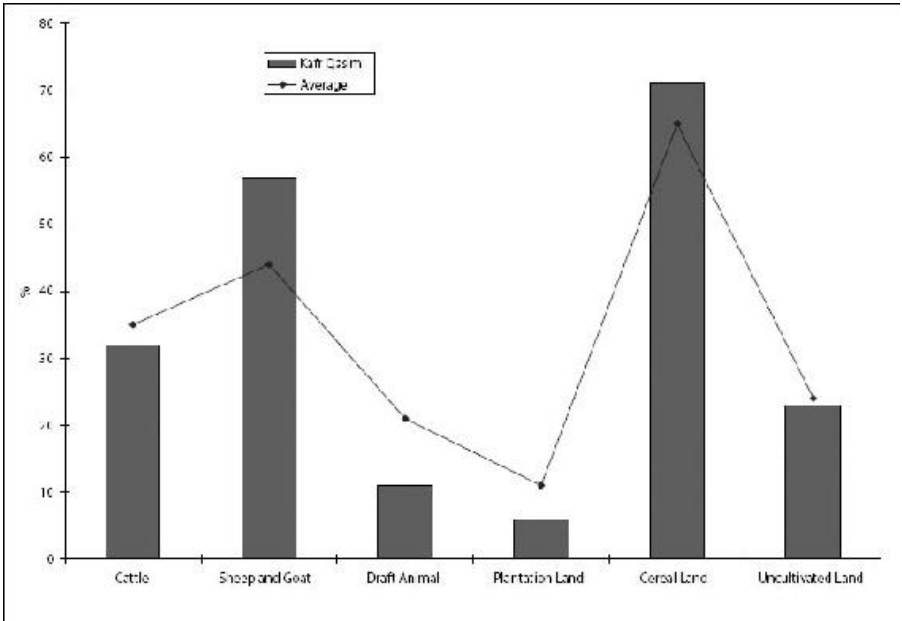


Figure 6.3 Relative frequency of livestock and land use in Kafr Qasim and the control group.

Meat and Milk Production and Their Nutritional Values

In order to evaluate the relative contribution of livestock to the human diet, the next step was to estimate the milk and meat that is produced by these species. The data, summarized in [Table 6.1](#), is based on vast ethnographic literature on milk and meat production (Brown 1971; Payne 1973; Dahl and Hjort 1976; Cribb 1984; 1991; Redding 1984; Epstein 1985; Perevolotsky 1986; Thomson *et al.* 1986; De Boer and Amir 1987; Perevolotsky *et al.* 1989; Abu Rabia 1994; Reid 1996; Groen *et al.* 1964; Widstrand 1975; Levy 1982; Russell 1988; Vigne 1991). Data on the meat, milk, proteins, fats and calories that are produced by livestock and data on the human requirements of these elements was compiled from various sources as well (Volcani 1925; 1938; Hirsch 1933; Brown 1938; Horwitz and Hinden 1938; Gyorgy 1960; Ilan 1974; Avitsur 1977; Guggenheim and Wolinsky 1981; U. Levy 1983; Epstein 1985; B. Rosen 1986; Rolfes *et al.* 2006). It should be emphasized that the data presented in [Table 6.1](#) refers to Middle Eastern breeds.

In order to calculate the amount of meat and milk that was produced, a theoretical simulation of milking and slaughtering procedure was carried out. A methodological note should be highlighted before demonstrating this procedure. The premise of this study is that the village economy was self-sufficient. Thus, a herd management strategy was to maintain a stable herd size. The herd, or part of it was not aimed at export (for elaborated discussion see Chapter 2 and Sasson 1998:4–5). The procedure of calculating the meat and milk production will be demonstrated on the virtual herd of Kafr Qasim. We may assume that the end of the productive life of males and females is around 5–6 years of age (Cribb 1991:29; Dahl and Hjort 1976:94). Thus, during a five-year cycle, approximately six rams (20% of the 31 adult males) would be slaughtered ([Table 6.2](#)). Culling young males is central for the preservation of pasturage and water for the females subsistence (Dahl and Hjort 1976:88; Hesse 1999:107; Davis 1987a: 157–60 and see Chapter 2). We may thus assume that all young males, excluding the number of adult males, which were previously slaughtered, would also be culled. Therefore, $122 - 6 = 116$ male lambs ([Table 6.2](#)). In order to maintain the ‘fresh blood’ principle, adult animals are replaced by a similar number of young ‘fresh’ animals that joined the herd. This mechanism reduces the risk of disease and helps to maintain a healthy herd by refreshing it regularly (Sasson 1998:9–10). This mechanism is also aimed at maintaining a stable herd size (Khazanov 1984:71; Barth 1959–60; 1962; 1964; Jochim 1981:164–84; Spooner 1973:40–1 and see Chapter 2). Thus, in the herd of Kafr Qasim, 175 adult females should be also slaughtered—equivalent to the number of young females that joined the herd ([Table 6.2](#)).

The same virtual slaughtering procedure was carried out on the cattle herd; 96 adult cows were slaughtered—equal to the number of calves that joined the herd ([Table 6.3](#), row 1 and 2).

The next step was to compute the total amount of meat produced, by multiplying all the slaughtered caprines and cattle by their edible meat weight (excluding their skeleton and blood; Vigne 1991:30 and see [Table 6.1](#)). The

amount of the milk that could be produced was computed by multiplying the number of adult female sheep, goats and cows by the estimated amount of milk they produce per year (Table 6.1). The fat, protein and calories that could be gained from meat and milk were also computed.

In order to calculate the meat, milk and primary nutritional components that would be required per person, the total amount of all animal products was divided by the number of inhabitants in each village (Government of Palestine 1945). For example, the total meat that could be produced by the Kafr Qasim herd is estimated at 21,053 kg. It is then divided by the total population of Kafr Qasim (n=1460) and by the number of days in a year. The results show a per capita estimate of 40 grams of meat per day (Table 6.4). Table 6.4 also shows the estimated annual cereal production for each village based on the size of the arable lands. (for further discussion, see Sasson 1998:12–14).

Animal	Live Weight (Kg)	Usable Meat (Kg)	Milk (Liters/ Year)	% of Fat in Meat	% of Fat in Milk	% of Protein in Milk	% of Protein in Meat
Sheep			50	22	7.5	5.6	20
Lamb	32	17.5					
Ewe	50	26	50				
Ram	75	35					
Goat			75	20	4.5	3.3	20
Kid	12	6					
Female	35	17.5	75				
Male	75	40					
Cattle	260	120	450	20	3.5	3.5	18

Table 6.1 Meat, milk and nutritional elements produced by Mediterranean livestock.

The results in Table 6.4 provide us with an estimated amount of milk, meat, protein, fat and calories that could be produced by caprines and cattle in the studied villages. More importantly, these results allow us to compare the relative contribution of agriculture and animal products to the human diet.

Discussion

The basis for our comparison is the average nutritional requirements per person. We may assume an average per capita daily intake of 450 grams of carbohydrates, 55 grams of fat and 55 grams of protein, which amount to 2400 kilocalories (Widstrand 1975:149; Groen *et al.* 1964; Ellison 1978:330; 1981:35–45; B. Rosen 1986:179; 1994:348; Guggenheim and Wolinsky 1981:218–20; Guggenheim 1995:84–5; Payne 1985:6; Jerome *et al.* 1980:30–1; Crawford 1993:91; Rolfes *et al.* 2006).

Proteins play an important role in growing, maintaining and repairing tissue; building enzymes, hormones, visual pigments, transportation and blood

clotting. Proteins are also the source of the amino acids. The essential amino acids cannot be manufactured by our body and must be obtained from proteins in our food. A food that contains all of the essential amino acids is defined as a complete protein source. Given that amino acids are not stored in the human body, obtaining regular quantities of high-value protein is an important subsistence goal for humans. Furthermore, if one essential amino acid is missing, other amino acids cannot be utilized. While plants and animals provide proteins, it is most likely that meat and milk, from animals, were, in ancient times, the primary source for complete high-value protein (Rolfes *et al.* 2006:181–203, see also Bavly 1947:40; Leonard 1960:195; Dahl and Hjort 1976:140–1; Bowen *et al.* 1995:905; Gross 1975:532; Guggenheim 1981:279; Jochim 1981:38). Of 55 gm protein per capita per day, 9 gm must be of a high value protein (Table 6.4, last row).

Age and Sex	Animals
Ram	31
Male Lamb	122
Female Lamb	125
Milking Female	382
‘Dry’ Female	98
Total	806

Table 6.2 The sheep herd in Kafr Qasim.

Age and Sex	Animals
Male up to 1 Year	41
Female up to 1 Year	56
Male in age 1–3	32
Female in age 1–4	107
Bull and Ox	15
Dairy Cow	147
Working Cow	146
Total	506

Table 6.3 The cattle herd in Kafr Qasim.

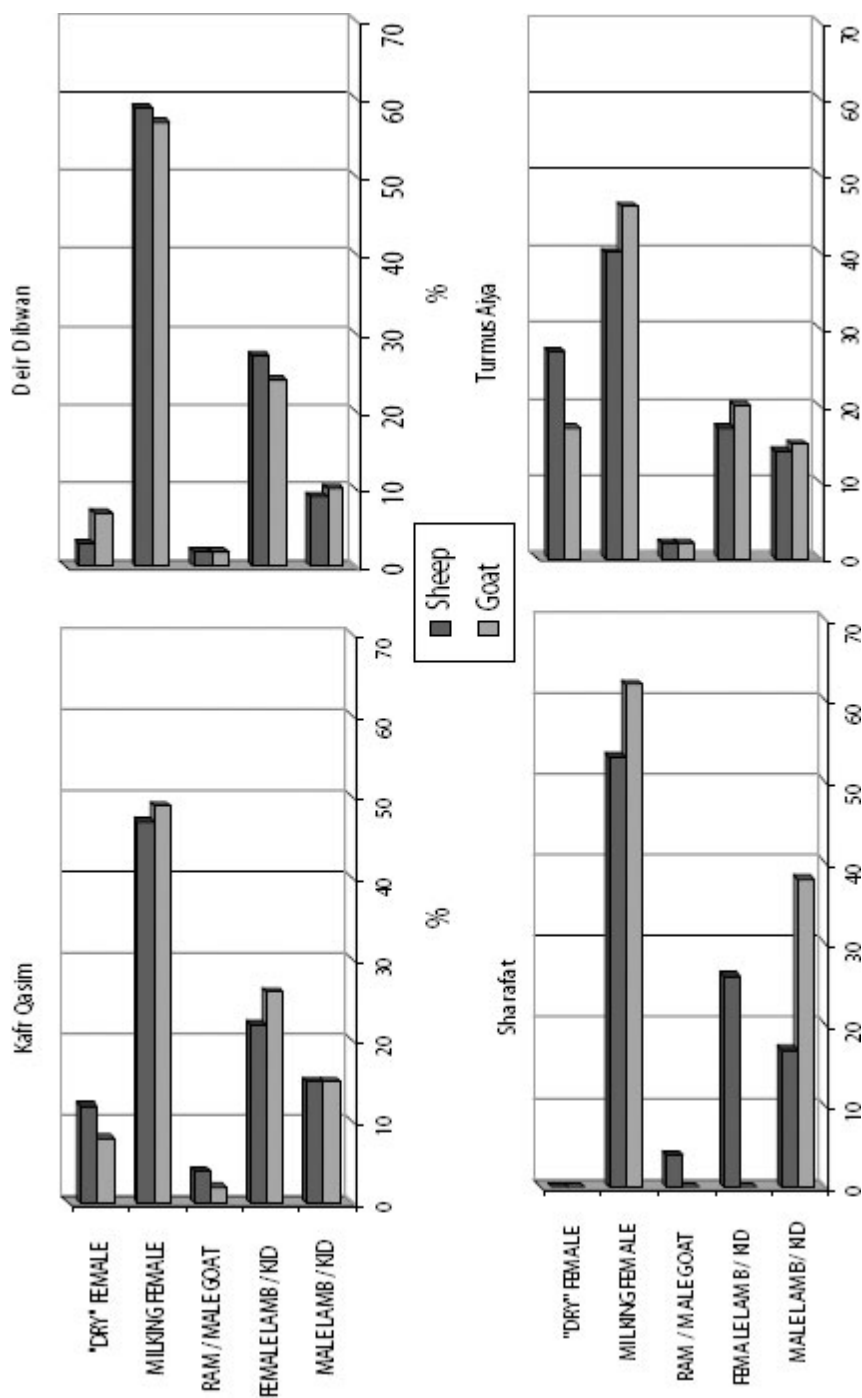


Figure 6.4 Caprine herd composition in the studied villages.

Apart from nutritional factors, other parameters representing the subsistence economy, were compared as well (Figure 6.5). For instance,

assuming cattle were utilized mainly for plowing (Sasson 2005a), their presence should be an indicator for dry farming. Assuming uncultivated lands were designated for pasture, their relative size may indicate the intensity of animal husbandry.

Several inferences can be made based on the data in [Table 6.4](#):

1. By using the energy (calories) component to evaluate the pastoral component ([Table 6.4](#), column 5), we may conclude that the contribution of caprines and cattle to the human diet varied from village to village as a result of differences in the geographical settings and economic potential.
2. Comparing the energy and protein columns ([Table 6.4](#), columns 4–5), it is evident that none of the flocks provided the total amount of energy (calories) or the total proteins required for the inhabitants.
3. On the other hand, in all villages, caprines and cattle provided the essential amount of high value protein.

It is apparent that even though animal husbandry played an important role in the subsistence economy of these rural sites, animals products were not the primary staple of their diet. This observation is widely invoked in the ethnographic literature (see for instance Groen *et al.* 1964:43; Palmer 2002:174) and this research provides us with quantitative data from four case studies to support it. The data presented here suggests that the principal goal of animal husbandry was to provide the essential high value proteins, which could not be obtained from plants.

An interesting correlations can be found between the size of the pastoral component (as measured calories) and land use. The contribution of pastoral products to diet of the village of Sharafat (as measured in calories), was small ([Table 6.4](#), column 5). This is not surprising considering the fact that the percentage of horticultural lands in Sharafat is substantially greater (50%) than the other villages ([Figure 6.5](#)). The village of Sharafat is situated in a region of long steep slopes that are not suitable, for the most part, for cereal cultivation or an extensive pasture. The slopes however were employed for building terraces for orchards, especially olive groves (Horowitz 1997:80; Lev-Yadun 1997:87; Finkelstein 1997a:117).

Village	Sheep Units per Person	Meat (In gr)	Milk (In gr)	Fat (In gr)	Protein (In gr)	Energy (In gr)	Cereals per Capita per Annum (In kg)
KAFR QASIM	2	40	272	19	16	236	140
SHARAFAT	1	39	85	12	11	150	50
DEIR DIBWAN	3.5	81	304	34	29	420	110
TURMUS AYIA	1.9	31	49	9	10	115	175
Requirements per Capita		35	250	55	9 ('high value')	2400	180

Table 6.4 Estimated per capita nutrition components produced in the studied villages and necessary nutrition components required per person.

The contribution of pastoral products to the diet of the village of Turmus Aiya (as measured in calories), was also small (Table 6.4, column 4). This village is located on a mountain ridge and encompasses wide agricultural valleys. Hence, the economy of Turmus Aiya was probably based on a mixed economy of animal husbandry, cereal crops and orchards (Figure 6.5).

The pastoral component in the village of Deir Dibwan is the highest of the examined villages (see also Finkelstein 1997a:113). The uncultivated lands, which most likely were used for grazing, comprised 78% of the total village lands. Namely, the land use distribution of this village clearly correlates with the calories produced by the village livestock (Figure 6.5).

The land use in Kafr Qasim shows that 70% of the lands were used for cereal cultivation (Figure 6.5). Given that the main role of cattle in pre-modern Levantine societies was plowing (Sasson 2005a), we may find a correlation between the high proportion of cereal lands and the high proportion of cattle (30% of the total livestock). The subsistence economy of Kafr Qasim was based, therefore, on cereal crops combined with animal husbandry.

It is worth noting that the mean diet per capita per day in Mandatory Palestine was comprised of 35 gm meat and 250 gm milk (Table 6.4, last row; Volcani 1938:25–30; Bavly 1947:41; Guggenheim and Wolinsky 1981:321). The data in Table 6.4 shows that the villages with the high pastoral component, Deir Dibwan and Kafr Qasim, produced an above average meat and milk while the villages with the low pastoral component, Sharafat and Turmus Aiya, produced a lower than average meat and milk.

Conclusions

This research allowed us a rare opportunity to investigate traditional, premodern economies, using quantitative data. The literature is rich with ethnographic sources discussing traditional and peasant economies. However, for the most part, it is based on personal observations of anthropologists coupled with occasional limited statistical data (Sasson 2006). The censuses, carried out by the British Mandatory Government of Palestine in the 1940s, are a goldmine of statistical data allowing us a comprehensive analysis of subsistence economies, animal husbandry and herd management as well as demographic analysis. The ethnographic data analyzed here, should shed light on animal husbandry in ancient times. For instance, it is striking that the relative frequency of livestock in Kafr Qasim of the 1940s is very similar to this of the neighboring archaeological site, Izbet Sartah, which is dated to the Iron Age I. In Kafr Qasim, caprines comprise 57% of total livestock, cattle comprises 32% and other draft animals 11%. In Izbet Sartah, the zooarchaeological data points to a herd composition of 55% caprines, 28% cattle and 17% of other draft animals (Sasson 1998:17–19; Hellwing 1986:147–9). Assuming the ethnographic

data presented here reflects ancient and pre-modern sedentary societies, we may conclude that these groups cannot subsist primarily on pastoralism. While this inference is not new, it is supported by quantitative data—livestock products provide only 5% to 17% (in calories) of the human diet in the studied villages. Animal products also do not provide sufficient fats or proteins required for a daily diet. The important conclusion arising from this research is that livestock provided the entire amount of high-value proteins essential for the human diet. It can be observed in all the studied villages and it may suggest that the provision of high-quality proteins was the primary goal of animal husbandry among sedentary and perhaps even nomadic groups. While it is not likely that ancient societies could measure protein and calorie intake, we may assume that they reached the proper balance of high-value protein through trial and error. The latter conclusion also points to the fact that sedentary societies were not dependent on animal products from pastoral-nomads. Sedentary groups were self-sufficient for the most part and were able to produce their own essential high-value proteins.

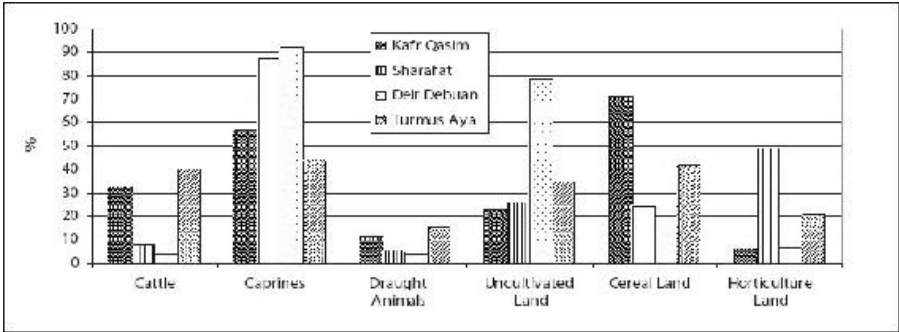


Figure 6.5 Relative proportion of caprines, cattle, draft animals and land use in the studied villages.

Conclusions

7

And I will lay sinews upon you, and will bring up flesh upon you, and cover you with skin, and put breath in you, and ye shall live; and ye shall know that I am the LORD (Ezekiel 37:6).

Four diverse perspectives on animal husbandry in ancient Israel were presented in this book: comparative, spatial perspective, sagittal and ethnographic. Each study contributed to our understanding of livestock and their remains from a different angle. Before making concluding remarks on the theme of this book, the survival subsistence strategy, other issues that require further study are worth noting. The spatial distribution analysis of faunal remains from Tel Beer-Sheba points to an interesting phenomenon: the relative frequency of animal bones found indoors is nearly twice the bones found outdoors. Does this phenomenon reflect taphonomic processes in tel sites or cultural habits of the Tel Beer-Sheba dwellers? This issue should be addressed by investigating additional tel sites. Another issue that requires further study is the models of food consumption in urban sites and their applicability to the Southern Levant. The spatial distribution of meat-rich and meat-poor body parts at Tel Beer-Sheba refutes models of indirect provisioning of meat. Is this phenomenon unique to Tel Beer-Sheba or does it reflect a pattern occurring in other urban sites in the Southern Levant? The taphonomic study carried out on the bone assemblage of Tel Beer-Sheba shows that cattle bones are more fragmented than caprine bones due to post-depositional processes and the archaeological excavation. Does this phenomenon reflect taphonomic processes in tel sites or is it unique to the faunal remains from Tel Beer-Sheba?

Despite three decades zooarchaeological research of the Southern Levant, many methodological issues remain unanswered. The taphonomic and GIS studies presented above raise additional questions and refine others. There is no doubt that further studies and more comparative data on food consumption in urban sites, interior and exterior bone accumulations, bone fragmentation and fresh breaks on bones, will bring us closer to answering these questions.

The Six Pillars of the Survival Subsistence Strategy

There are after all two roads to satisfaction, to reducing the gap between means and ends: producing much or desiring little (Sahlins 1971b:49).

All four perspectives on animal husbandry point to a common denominator: the Bronze and Iron Age Southern Levantine household maintained a survival subsistence strategy rather than a market-oriented strategy. All the studies presented here indicate that the prevalent economic system was a 'closed' economy (Safrai 1994:415), conservative and self-sufficient. A market economy

and the survival subsistence strategy are both long-term strategies. Hence, a market-oriented strategy should be characterized with continual trade transactions rather than random exchange or reciprocity. We may assume that if households or sites maintained a market oriented strategy, they would specialize in particular products for trade, they would strive to gain wealth and their surplus would be directed to exchange. No evidence was found to support the market economy model.

The survival subsistence strategy represents, in many ways, a complete contrast to the market economy—trade transactions are rare and stability is preferred over gaining profit. I shall list and demonstrate the underlying principles behind the survival subsistence strategy:

1. Self-sufficient economy: households trading their products in outside markets might gain profit and accumulate wealth. However, their subsistence economy is thus dependent on market demands and external forces. Consequently, these households increase risks and fluctuations in their subsistence base and are substantially more vulnerable (see below). For that reason, we find evidence for a self-sufficient economy in most Bronze and Iron Age Southern Levantine sites as well as in traditional, premodern households in various regions of the world. A self-sufficient economy relies on various livestock species and diverse agricultural branches, which produce the primary requirements of a household. Establishing economic independence, even at a minimal level of subsistence, is a principal pillar of long-term survival.
2. Minimizing risks: by breeding cattle beyond or close to carrying capacity, a surplus of meat and milk, which could be traded with external markets, would be created. However, that would endanger the ecological equilibrium and increase risks. Hence, in most regions of the Southern Levant, cattle were kept in limited numbers.
3. Minimizing fluctuations and maximizing stability: increasing the size of caprine herds in years of abundant pasture would generate a surplus of meat, milk and wool for market exchange. However, this would result in escalating fluctuations (of herd size in this instance). Hence, herd size was normally kept at a stable size that was consistent with the minimum level of carrying capacity. Consequently, the size of the human population, which was dependent on herd size, was maintained *below* carrying capacity as well.
4. Optimal utilization of resources: when livestock was slaughtered, all body parts were consumed, including these of low utility index. In addition, caprines and cattle were utilized for a whole range of products rather than specializing in a particular product. Optimal utilization practically expanded the subsistence base. In a market economy, on the other hand, not all subsistence resources were utilized: the diet of an elite population, for instance, would consist primarily of select body parts and

households maintaining a market-oriented strategy would specialize in a limited number of products for trade.

5. Preserving subsistence resources (e.g. livestock, water, agricultural and pasture lands): even when water and pasture resources allowed the increase of herd size, it was maintained at a stable size. This principle does not stand in contrast with optimal utilization of resources. On the contrary, even when all natural resources were utilized to produce an adequate subsistence, the resource base was preserved and was not depleted. The preservation of the subsistence base was also accomplished through minimizing risks and fluctuations, which secured a long-term survival.
6. The reason the survival subsistence strategy has been sustained for thousands of years is obvious; it has been historically proven successful. Maintaining this strategy was fundamental to the household's existence. It overcame and probably dictated social forces and dynamics.

The Survival Subsistence Strategy and the Zooarchaeological Perspective

The focus of this book is bones. It may come as a surprise to some that most of the behavioral ideas regarding our ancient past are dependent on the interpretation of faunal remains and depositional context... (Binford 1981:1).

The notion of a self-sufficient economy in the Bronze and Iron Age has been discussed before. However, those who advocate models of self-sufficient economy also advocate to some extent a specialized economy (i.e. market economy). I argue that the survival subsistence strategy stands in clear contrast with a market economy. In other words, a household, which maintained a survival subsistence strategy, would not be engaged, even partially, in a market economy. King and Stager, who studied the economy of ancient Israel, affirm, for instance, that the survival subsistence strategy was paramount—'Householding rather than market exchange, was paramount' (King and Stager 2001:192). They also assert: 'the household was designated to maintain its own economic survival, even if only at minimal level' (ibid). Nonetheless, on the same page they claim: 'There was even a degree of specialization in some villages...' (ibid). They also assert: 'We can postulate that larger communities, such as Hebron, Jerusalem and Shechem, functioned to some degree as regional markets for village produce, which could be brought and sold in a more urban settings' (ibid). The survival subsistence strategy was a conservative lifestyle that favoured a stable livelihood over generating profits. Households that followed this strategy would not engage in specialized production or market-oriented economy. Specialized economy or dependence on outside markets increased risks and compromised a long-term survival. We may make use of a phrase made by Sahlins (1971:49) to describe this strategy: a

household that maintained the survival subsistence strategy would choose desiring little upon producing much. Given that the survival subsistence strategy was paramount, we may deduce that a system of market economy was uncommon in the Southern Levantine Bronze and Iron Age. Evidence supporting the notion of the survival subsistence strategy can be found in all four studies of animal husbandry that has been discussed in this book:

1. The extensive anthropological literature demonstrates that pastoral-nomadism should be associated with the survival subsistence strategy. It enabled nomads to exploit effectively marginal ecological niches, avoid competition with other groups, minimize the spread of disease and evade the control of central governments. Ethnographic data also show that the Southern Levantine pastoral-nomads were able to maintain a self-sufficient economy, thus were not dependent on a sedentary population for their grain products. Due to the limitation of archaeology, it is difficult to estimate the size of the nomadic population in the Bronze and Iron Age. Yet, it would be reasonable to assume that large portions of the population were nomadic.
2. Given that maintaining long-term survival is a specialized strategy, we may deduce that sedentists and particularly pastoral-nomads that underwent a process of behavioral, cultural and ideological adaptation to a habitat (i.e. specialization) would be reluctant to relinquish it. This may be demonstrated in an analogy drawn between animal species occupying adjacent habitats and human 'sister-species'—the 'Homo sapiens nomadus' and the 'Homo sapiens sedentus'.
3. The comparative perspective of zooarchaeological and ethnographic data from 70 sites and strata in the Southern Levant also supports the notion of the survival subsistence strategy. The sheep/goat ratio analysis shows that a regional pattern cannot be traced. In 76% of 57 sites and strata, the percentage of sheep does not exceed 67%. This indicates that caprine herd management was a strategy focused on herd security and survivorship. By comparing the zooarchaeological data with data from the British census we notice a dramatic shift in the proportion of sheep, from approximately two thirds in the Bronze and Iron Age to one third in pre-modern times. Bearing in mind that goats represent herd security and sheep represent the demand for wool, the cause for a dramatic drop off in sheep proportion in premodern times was that wool was no longer essential for textile production. Given that the survival subsistence strategy was sustained in premodern times, the proportion of goats increased in order to maximize herd security.
4. The comparative analysis also shows that in 45 of 54 sites (83%), caprines were utilized for a whole range of products rather than for select products (meat, milk or wool). The results point to a self-sufficient economy that was prevalent in all periods, geographical regions and both

rural and urban sites. Culling sub-adults as well as mature animals is a coherent ecological mechanism focused on sustaining a large number of females who were responsible for milk production and reproduction of the herd. This mechanism of herd management does not indicate trade in animals and it coincides with the survival subsistence strategy.

5. Cattle husbandry was reexamined with regard to previous studies. It was concluded that: a) cattle is overrepresented in the zooarchaeological record (see clause 8 below); b) the abundance of cattle does not point to agricultural intensification. Maintaining adequate dry farming does not require a large number of cattle and their proportion certainly would not exceed 20% of the total livestock; c) cattle was not the primary source of meat; d) a pattern pointing to decline in the relative frequency of cattle that follows climatic decline (corresponding with the north-south gradient) could not be observed. Cattle husbandry was a precarious task due to their demand for large quantities of water and pasturage. However, cattle were essential for plowing. The comparative perspective shows that breeding cattle in high proportions would endanger the ecological resources. High carrying capacity in the Coastal Plain and the Northern Valleys, on the other hand, enabled the breeding of cattle in moderate proportions (33% on average). Therefore, a low proportion of cattle (*ca.* 15%) in many Southern Levantine sites was aimed at sustaining the equilibrium between the survival subsistence strategy and the demand for plow beasts. If we would eliminate the environmental limitations, cattle would be the best suitable for the production of meat and milk. This hypothesis is supported by the fact that Modern diet consists largely of cattle products. The relatively low proportion of cattle in antiquity versus the high proportion of cattle in Modern times reflects the contrast between the survival subsistence strategy in antiquity and a market economy in present times.
6. The spatial perspective was demonstrated by a GIS spatial analysis of faunal remains from Tel Beer-Sheba. We may assume that the zooarchaeological record pertaining to upper class households would reflect a relative abundance of young livestock and meat-rich body parts. However, meat-rich and meat-poor body parts as well as caprines and cattle of all age groups were found in all areas of Stratum II of Tel Beer-Sheba. A specialized economy may be tied with a socioeconomic complexity (cf. McCorriston 1997). Hence, evidence for social stratification in Tel Beer-Sheba would have supported the market economy premise and vice versa. The spatial perspective points to a self-sufficient economy, which is a primary component of the survival subsistence strategy.
7. The sagittal perspective supports the notion of the survival subsistence strategy through a taphonomic study of faunal remains from Tel Beer-Sheba. Four primary taphonomic phases that might have affected the

bone assemblage were analyzed. In the first phase, the utilization of animals by man was studied. The analysis of body part representation indicates that caprines and cattle were not brought to Tel Beer-Sheba from outside markets and they were butchered and consumed at the site. Analysis of the frequency of skeletal elements and their utility indices points to a food maximizing strategy, namely, all body parts, those of high utility as well as those of low utility, were consumed at the site. This pattern stands in contrast with the hypothesized behavior of an urban and elite population that would select, for the most part, body parts of high utility. One of the pillars of the survival subsistence strategy is optimal utilization of resources, which is represented in this study in the food maximizing strategy.

8. The sagittal perspective provided us with an enhanced understanding of the representation of cattle in zooarchaeological assemblages from tel sites. The study showed that three taphonomic agents, bone fragmentation during post-depositional processes, as well as bone collecting and bone fragmentation during the archaeological dig, may cause an overrepresentation of cattle in bone assemblages. According to the survival subsistence strategy model, we should expect a relatively low proportion of cattle in most Southern Levantine sites. The sagittal perspective supports this model: it is most likely that cattle proportion should be lower than it appears in many faunal assemblages (10%-15%). Discussions of the relative frequency of cattle, which neglect to address fragmentation, fresh break and bone size agents, would lack crucial data for assessing this issue.
9. The ethnographic perspective made use of ethnographic data compiled from demographic and animal censuses carried out by the British Mandatory Government of Palestine in the 1940s. The study demonstrates that although the contribution of livestock to the human diet is relatively low, caprines and cattle provided all the high-value proteins essential for the human physiological survival. The age profile of caprine herds from various geographical regions of the Central Hill country shows a striking similitude. This fact points to a prevalent pattern of herd management that focused on females, which were vital for herd reproduction as well as for milk production. This age profile indicates a non-specialized economy that utilized the whole spectrum of livestock products (such as meat, milk or wool). Self-sufficient economy and optimal utilization of resource are two pillars of the survival strategy.

It is beyond the scope of this book to reassess the archaeological evidence that may suggest that trade and a market economy were prevalent in the Southern Levantine Bronze and Iron Age. Since the zooarchaeological data negate these notions, I shall highlight a methodological question about the archaeological

evidence. Import wares to Southern Levantine sites may be considered an indication for trade and a market economy. (e.g. Mycenaean or Phoenician pottery). However, the archaeological evidence for trade and a market economy ought to be addressed statistically. In other words, if the number of the import vessels or other artifacts is small, it certainly does not support continual trade transactions or a market economy system.

In conclusion, this work provides us with much evidence from diverse perspectives that the survival subsistence strategy was prevalent in the Southern Levant Bronze and Iron Age. It is apparent that Western concepts and analogies to the Roman world and later periods led many scholars to argue that a market economy was prevalent in the Bronze and Iron Age. However, the lack of zooarchaeological, ethnographic and anthropological evidence to support this notion is striking.

Previous studies have demonstrated that food waste (faunal remains in our case) is socially and economically defined. Zooarchaeology is practically a midden excavation. The analysis of this dig showed, from various perspectives, that the common household was focused on maintaining stability, minimizing risks and sustaining a long-term survival rather than gaining wealth or improving its livelihood.

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